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**THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.**

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## Forthcoming Events.

APRIL 29.

*Royal Society of Arts*:—Ordinary meeting in London. "Stainless Metals," lecture by Sir Harold Carpenter, M.A., F.R.S.

MAY 6.

*Institute of Metals*:—General meeting in London. Annual May Lecture by William B. Woodhouse, M.Inst.C.E., on "The Progress of Power Production."

**Institute of British Foundrymen.**

APRIL 24.

*London Branch (Junior Section)*:—Annual general meeting in London.

APRIL 25.

*Lancashire Branch (Junior Section)*:—Annual general meeting. Short Paper competition.

*West Riding of Yorkshire Branch*:—Annual general meeting.

*Lancashire Branch*:—Special meeting at Manchester. Paper by Monsieur E. Ronceray, "Sand and Sand Preparations."

MAY 2.

*Lancashire Branch*:—Last meeting of the Session. "The Manufacture of Large Marine Propeller Castings," Paper by Wesley Lambert, C.B.E., A.K.C.

## Cinderella's Beauty Parlour.

Situated as we are in the centre of the British Empire, we cannot fail to be impressed with the development of the architectural features of London's latest buildings. At the moment, the tendency is to include as much stainless material and as few curves as possible. It certainly presents a striking and novel appearance, but large-scale expansion will probably produce nausea, and a reversion to "period" treatment.

This modern architecture is liable—like last year's ladies' hats—to "date," and become rapidly old-fashioned. The basis of this movement and its associated development, metallic furniture, provides little, if any, more work for the foundries than older designs, and we feel that an opportunity is now presenting itself to the foundry industry, in collaboration with "Chelsea," for a serious share of future business in building developments. If designers wish to proceed with their present vogue for the garish and bizarre appearance of building, the foundry industry can supply them with coloured cast-iron bricks or slabs in infinite variety. If, on the other hand, fashion decrees a reversion to "period" design, involving in some cases ornamentation, no matter from what angle these potential demands are examined, added interest is given to the fettling and finishing shops, to which the appellation of "Beauty Parlour" is no misnomer. Actually, it provides the foundry industry with a weapon for competition against wrought and non-metallic material, which up to now has scarcely been brandished, let alone used. Herein minor defects can be remedied, surfaces can be modified and improved, and colour bestowed, whilst castings can be made as incorrodible, by treatment, as stainless steel. Whilst the Beauty Parlour notion is obviously somewhat extravagant, the postulation of the reverse—that is, that some fettling and finishing shops resemble the slapdash methods of the village pump or the kitchen sink—is no exaggeration.

## Patent Law Reform.—I.

Nearly two years ago we commented on the appointment of a Government Committee to consider if any amendments were needed to the Patents Acts, and last month the Committee laid its report before the House of Commons. The personnel of the Committee did not excite any particular enthusiasm at the time, and in a sense the report is disappointing, because the Committee appears to have played for safety by recommending a number of minor changes, but have not welcomed some of the larger suggestions put forward by people who have followed the working of the Patents Acts.

Some of these were embodied in a report of the British Science Guild, and they found a good deal of response generally. The subject is of great importance, and it effects every manufacturer sooner or later. A man who has or who is licensed to use a patent is just as anxious to keep out infringers as the man who is not licensed is anxious not to be deprived of the advantages of the patent. The patent system originated in England and in some respects our system is still the best in the world. The value attached by industry to the system is shown by the fact that during 1905-13 some 30,000 applications for patents were made per annum to the British Patent Office. During the years 1928-30 it has approached 40,000 per annum, and there are at the moment over 10,000 applications at the office awaiting the action of the examiners.

We select a few of the conclusions of the Committee that are likely to interest our readers. The time limit for the filing of a complete specification is recommended to be twelve months (with extension on payment of a fine to thirteen months) instead of nine months. The Patent Office duty of examining prior British specifications within the previous 50 years for anticipations remains, but it is recommended that the scope of the search for novelty be extended to any books, documents or foreign specifications which are likely to offer anticipation. This is an eminently common-sense solution of the problem, for the imposition of the complete search as a statutory duty would enormously increase the expense of patenting, and yet without it British specifications do not carry the same guarantee of novelty as certain foreign specifications where the search extends to general documentary material. Experts are likely to know where evidence of anticipation is likely to be found.

There are several other important recommendations, particularly relating to threats issued by a patentee regarding infringement, which would tighten up the law on a point of great interest, and we propose to return to this in our next issue.



XUM

## Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

### Apprentice Training.

*To the Editor of* The Foundry Trade Journal.

Sir,—There appears to be a totally mistaken idea as to the possibilities of the evening classes held at various colleges for the training of the foundry apprentice. The writer read the short article by Mr. S. White that appeared in The Foundry Trade Journal for February 26. Mr. White sweepingly discredits the system. He is obviously writing without full knowledge on the subject. The writer also read, a few days ago, the proceedings of the meeting by the Nottingham Society of Engineers, November 24, 1930, containing a lecture given by Mr. Stevenson; here also the lecturer appears to be speaking without full knowledge of facts, also without giving the matter adequate thought, for he says: "The technical colleges have long since realised that practical foundry work cannot be taught in the lecture theatre." The writer would point out that it has never been tried, for practical chemistry or physics, naturally practical subjects, are taught in laboratories. The lecture theatre is for theoretical subjects. The difficulties to be associated with difference in the ages of students mentioned by Mr. White are overcome in properly-organised classes by classification on this basis. One night caters for ages 15 to 16, whilst another 17 to 18, and so on. The writer would like to have the opportunity of showing what is being done at the County Technical College, Mansfield, for the foundry apprentice; then, perhaps, such critics would change their opinions. At Mansfield there are about 30 apprentices receiving expert instruction in practical and theoretical subjects. On the practical side they have a good-size foundry where quite large work is carried out. It would appear, too, that such gentlemen as mentioned imagine that the theoretical side of the foundry training, even for apprentices—that is, apart from the student or pupil element—does not exist, or if it does is of no importance. The writer would like to point out, however, that without this side the practical work is useless and becomes rule-of-thumb, a method our grandfathers adopted. In conclusion, the writer would suggest that if, instead of people criticising, they would get down to facts and help to instruct or make instructive suggestions, we should be far better placed.—Yours, etc.,

J. H. List,
Lecturer and Instructor, County Technical College, Mansfield.

[The above letter has been slightly amended. We seem to remember that Mr. List's previous correspondence on this subject contained an appeal for national certificates for foundry students. Now that has been organised, we suggest that Mr. List should officially identify himself with this scheme, after which he would realise that both Mr. White and Mr. Stevenson were only giving publicity to the generally-accepted scheme together with a few personal notions for modifications based on local conditions.—Editor.]

### Cupola-Melted Malleable Cast Irons

*To the Editor of* The Foundry Trade Journal.

Sir,—I am very interested in the letter appearing upon this subject, and note with interest that Mr. Christian Kluijtmans claims to have produced blackheart malleable in the cupola from steel and ferro-alloys as far back as 1927, and has a patent in England dating from that year.

It may be of interest to him to know that, whilst acting as foundry metallurgist to Messrs. John Crowley & Company, Limited, malleable ironfounders, Sheffield, I produced malleable iron of the blackheart variety by a similar process in 1920-21 with quite satisfactory results. The chief reason for not continuing with this was that the yield point was considerably lower than in the case of the Réaumur malleable. In view of this the process now discussed would not appear to be anything new.—Yours, etc.,

C. Wood.

Beecroft & Partners, Limited,
Retort Works, Mappin Street, Sheffield,
April 21, 1931.

## Notes from I.B.F. Branches.

*Lancashire Junior Section.*—The Junior Section of the Lancashire Branch of the Institute of British Foundrymen held its annual social at the New Continental Café, Oxford Road, Manchester, on April 11. Among the guests present were Mr. R. W. Stubbs, Lancashire Branch-President; Mr. E. Flower, Vice-President; Mr. Phillips, Vice-President, and Mrs. Phillips; Mr. and Mrs. W. Jolley; Mr. Tom Makemson, General Secretary of the Institute; Mr. S. Southcott, of Briton Ferry, and Mr. and Mrs. R. A. Miles.

The evening commenced with a whist drive, the prizes for which were afterwards presented by Mrs. Grundy, wife of the Junior-Section Chairman.

The remainder of the evening was devoted to dancing, and at the close it was generally agreed that the social was the most successful and enjoyable as yet held by the Section, the thanks of which are extended to the many kind friends who subscribed to the fund for the whist-drive prizes.

*Newcastle and District Branch.*—With sincere regret we learn that Mr. F. Sanderson has been obliged, through illness, to relinquish the office of honorary secretary of the Newcastle and District Branch of the Institute of British Foundrymen. The Branch Council has unanimously expressed the desire to recognise his long and valuable services by a monetary presentation, and a fund has, therefore, been opened, to which it is hoped that his many friends throughout the industry will subscribe. Subscriptions will be gratefully received by either the Branch-President, Mr. A. Logan, of Messrs. Hawthorn, Leslie & Company, Limited, St. Peter's Works, Newcastle-upon-Tyne, or Mr. Sanderson's successor as secretary, Mr. J. W. Eckford, 4, Mosely Street, Newcastle-upon-Tyne.

**Detinning Tinplate Scrap.**—A new process for detinning tinplate scrap is discussed by Messrs. W. W. Scott and N. E. Davis in "Industrial Engineering Chemistry." It is based on the fact that dilute solutions of tartaric acid dissolve tin in the presence of an excess of air or oxygen while the iron is unattacked. The detinning apparatus used consists of a perforated steel cylinder which contains the tinplate scrap. The cylinder is turned on a steel shaft which passes through the length of the cylinder and detinning tank. In the detinning process the solution level is regulated to cover about one-third the cross-sectional area of the cylinder. The scrap is subjected to the alternate action of acid and air. Three hours is found to be the most efficient length of time to conduct detinning, and the acid is most effective at 5 per cent. concentration. After detinning the solution contains stannous tartrate. The tin may be recovered from the solution by precipitation as sulphide with hydrogen sulphide. The tin from the stannous tartrate is replaced by the hydrogen from the hydrogen sulphide and tartaric acid is recovered. There is a slight loss of tartaric acid in this reaction owing to decomposition, which is about 0.10 gramme of acid per gramme of tin recovered. The tin sulphide may be converted into the chloride by treating with hydrochloric acid. The detinned scrap contains about 0.10 per cent. of tin, which is sufficiently low to render it suitable for steel-melting scrap.—"The Iron Age."

## Random Shots.

If "Marksman's" mind were less occupied with altogether trivial matters, he would this week pen an illuminating and controversial review of certain current political upheavals in Western Europe; and would not fail to include a few of the customary "startling disclosures" which such disturbances jar off the top shelf. As it was, his innately pacific disposition led him to the Ideal Home Exhibition, there to gaze vacuously at long-haired virtuosos controlling "player-pianos," to be toppled into "chairs that are different" to demonstrate their floating frames (whatever they are), to be asked urgently whether his home was complete (*i.e.*, containing Somebody & Someone's vacuum cleaner, gas fire, parquet flooring, dog kennel or grape-fruit preparer), advised earnestly to use *the* dental cream (which All the World's Most Beautiful Women are using), and to be caught up in the stream of expectant young men flowing towards the Terrace of Beauty and finding there, not lissom young maids in—and nearly out of—skin-tight bathing costumes (*honi soit qui mal y pense*), but beauty concentrated in the bottle, so to speak.

* * *

True, that one "ideal home" is graced with an imposing chromium-plated metal front door. But the room with a copper-covered floor, aluminium-panelled walls inset with bronze radiator grilles, stainless-steel ceiling, steel and aluminium furniture and the various minor fittings of non-ferrous metals has yet to appear and appeal, however much the manufacturers of metal polishes may like the idea. . . .

* * *

Despite the 3½-ton petition of the Lord's Day Observance Society—whose activity is matched only by the barman's on a Sunday evening—the second reading of the Sunday Performances Bill has been carried. The more pessimistic probably raised their hands in horror at the first hint of the legalised Sunday opening of cinemas, and have taken it as a sign of the nation's moral decadence. But common sense surely dictates that if the public really do want cinema entertainment on Sundays they should have it. The cinema is an innocent form of amusement, and the usual happy endings demanded of it by the unsophisticated, even more efficiently than innumerable grey-bearded censors, rule out anything likely to lower the moral standards of our young people.

* * *

Imaginary Intimate Interviews.

III.—*The Foundry Apprentice.*

Eh! an' Ah do like workin' in t' foundry. Ah gets there in mornin' at ten, and Mister Fiddlesticks—our foreman, tha knows—coams up an' says, "Tha's slept well last neet, Albert?" Very anxious o' my health is he. Yesterday he says, "Coom 'n' look at big turbine castin' mould yonder. It's urgent job, but Ah've kept it oppen since eight to show thee cores and drawbacks." So Ah has a look, and 'bout eleven ould Bob Sprigg—moulder Ah works with—says, "Albert, go an' get the sen a pint o' milk. Growin' lads need lots o' milk." So Ah has my milk an' rest afternoon goes t' foundry classes. Then, in evenin', Ah sits in public library to read Foundry Trade Journal an' my dad cooms wi' me to see football results. Ah'm gettin' my little brother to coom t' foundry when he leaves school! An' mister, if Ah has any nippers, they're coomin' t' foundry as well. Boys'll be moulders an' girls coremakers! Eh, an' it's grand in t' foundry!

Marksman.

# The Brackelsberg Process for the Production of Grey Iron.*

By Dr. P. Bardenheuer.

Cast iron is by far the most important metal used in machine construction, and because of its excellent casting and machining qualities it has considerable advantages over steel and the costlier non-ferrous metals. The development and progress of mechanical engineering are ceaseless. This has resulted in the demands made on the physical properties of all materials used in machine construction becoming increasingly stringent, and in welded rolled iron threatening to supersede cast iron to a very great extent. For these reasons the ironfounder will have to be very resourceful if cast iron is to maintain its pre-eminent position in the engineering world. He must improve the physical properties of his product, make production more reliable, and reduce prime costs; to do this he will first have to examine his melting process, for it is mainly on this that the quality and prime cost of his product depend.

The following question will be discussed in this lecture: "How far does the Brackelsberg furnace fulfil the demands made by the ironfounder on a modern melting plant, and how far can it help to improve the quality and reduce the cost of cast iron?"

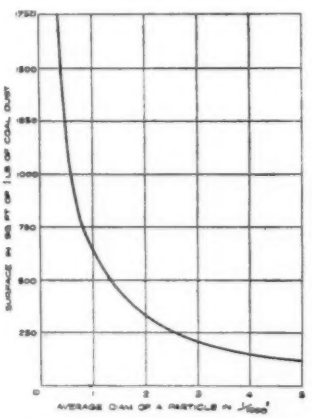

Fig. 1.—Relationship of Surface Area and the Fineness of Dust.

### Advantages of Pulverised-Fuel Firing.

Coal-dust firing has already been used in such a multitude of ways that its advantages are well known. The most important is that the fuel, being in a very fine state of division, can react extremely quickly with the oxygen in the blast, so that complete combustion is attained in the shortest possible time without any excess air being required. By this means the theoretically highest possible temperature is obtained. The flame is extraordinarily efficient because it develops in the furnace, complete combustion taking place immediately in front of the burner mouth, and full use being made of the difference in temperature between the flame and the charge.

Further advantages of coal-dust firing are: (1) The flame can easily be regulated, (2) simple supervision with little labour, (3) minimum of stoppages and repairs, because all parts are outside the combustion chamber.

When selecting a coal suitable for melting purposes, the calorific value and the degree of fineness to which the coal is ground are of the greatest importance. The larger the surface area of two materials, the greater the speed with which they can react on each other. Thus, when coal dust is mixed with the blast and blown into a furnace, the speed of combustion depends on the fineness of the coal.

Fig. 1 shows the relation between the surface area of 1 lb. of coal dust and the average diameter of the dust particles. From the graph it can be seen that, if the average diameter of the dust particles is 5/1,000 in., the surface area of 1 lb. of coal dust is roughly 125 sq. ft., but that if the average diameter is reduced to 1/2,000 in., the surface area is increased to about 1,250 sq. ft.

Dr. P. Bardenheuer (the author).

### Varying Volatile Content with Influence.

The first phase in the combustion of coal dust is the ignition of the volatile constituents, but the finer the dust and the higher the temperature, the less does combustion actually depend on this ignition of the volatile constituents; in fact, if the coal is ground sufficiently fine and, what is even more important, the temperature is sufficiently high, the volatile content has no influence on the development of the flame. When using grate firing the volatile content can influence the length of the flame, but it cannot do so when using coal-dust firing because the speed of combustion is too great. The flame temperature depends on the number of heat units developed in the furnace chamber, and so the calorific value of the coal is the most important thing to consider. In this connection Table I, compiled by the Rhine & Westphalia Coal Syndicate, giving the highest temperatures that can be obtained using coals of varying volatile content, is of great interest. From Table I it can be seen that the flame temperature does not depend on the volatile content of a coal.

Table I.—*Relationship between Volatile Content and Flame Temperature.*

| | Volatile content. Per cent. | Flame temperature. Deg. C. |
|---|---|---|
| Gas coal .. .. | 35—40 | 2,216 |
| Bituminous coal .. | 19—30 | 2,234 |
| Forge coal .. .. | 12—19 | 2,227 |
| Anthracite .. .. | 8—12 | 2,238 |

### Eliminating Disadvantages.

There were in the past considerable disadvantages from a metallurgical standpoint to set against the advantages outlined above of using coal-dust firing in melting furnaces. When producing pure metal alloys, the impurities present in the fuel made it impossible to use this firing direct in the furnace. Even when using very pure coal dust in a reverberatory furnace to melt cast and malleable iron, so much sulphur was absorbed from the combustion gases and from the ash deposited on the bath that the metal became extremely impure. In many cases attempts were made to overcome this difficulty by building a wide combustion chamber in front of the furnace. This had the effect of reducing the speed of the combustion gases and so enabling the greatest part of the ash to be deposited in the combustion chamber, but it prevented full use being made of the high flame temperature developed immediately in front of the burner, and so lengthened the melting process. This was undesirable, as any delay in this process is bad for the metal. It was found to be quite impossible to melt in an acid hearth because of the deleterious action of the sulphur in the coal.

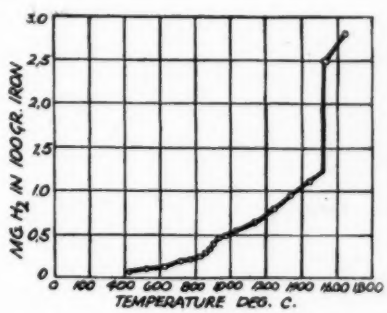


Fig. 2.—The Solubility of Hydrogen in Iron with Increasing Temperature.

The problem of successfully utilising coal-dust firing, with all its concomitant advantages, in melting furnaces for the production of pure and high-quality metals and alloys was first solved by the late Carl Brackelsberg. In all metal-melting processes the first and most important principle is: "Melt as quickly as possible, so that the charge has the shortest possible time to absorb gases and oxides from the furnace atmosphere."

### Speed of Melting and Gas Solubility.

It is safe to assume that the solubility of gases in iron usually conforms either to the same or to a similar law as that evolved by A. Sievertz for the solubility of hydrogen in this metal. Fig. 2 shows the results obtained by Sievertz. Until melting point is reached solubility only increases gradually; it then increases very rapidly, but when the temperature is raised further, it resumes its gradual rate of increase. This law has a great influence on gas absorption during a melt, and gas separation during solidification. It is important to see that the metal is exposed to the furnace gases for as short a time as possible whilst the charge is being melted down, so that it cannot become saturated during this period. When once the melting point has been exceeded, the solubility of the gases in the metal increases, and it is then essential to protect the bath from the actions of the gases. The rate of separation of

* A Paper read before the Newcastle Section of the Institute of British Foundrymen, Mr. A. Logan presiding. The author is a chief metallurgist with the Kaiser Wilhelm Institute at Düsseldorf.

gases from an iron saturated with them corresponds to that given in Sievertz's curve. The greatest part only separates out after the metal has begun to solidify, i.e., most of the gas separates out in the mould, forming a defective casting. The solubility of oxides in iron also increases with the temperature, so that gas may be produced in the molten iron as a result of a chemical action between these oxides and carbon.

### Impurities Expelled.

Brackelsberg adhered to the principle of melting as quickly as possible in order to prevent the metal becoming saturated with gases and oxides. He produced the hot coal-dust flame direct in the furnace, and so fully utilised for melting purposes the heat developed by it. He obtained a further advantage by using a rotary drum furnace, because, in this, heat can be transmitted to the charge quickly and uniformly. He also overcame the metallurgical disadvantages of a coal-dust flame, due to the impurities present in it, *by sending the fuel and the blast into the furnace at such a high speed that all*

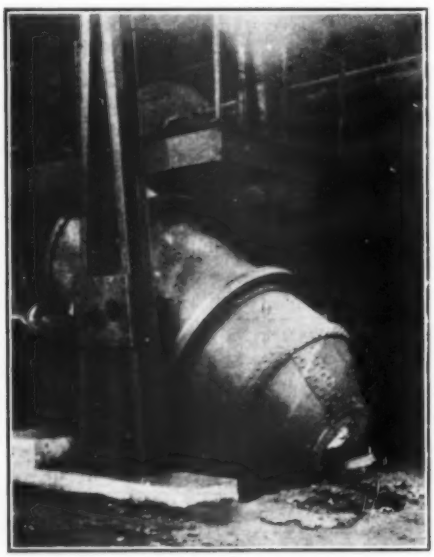

Fig. 3.—A Furnace of 1 to 1½ Tons Capacity used for Experimental Work, shown in Charging Position.

*impurities were blown out with the waste gases.* When operating in this way it is possible to make full use of the extremely high temperature of the coal-dust flame without in any way affecting the purity and quality of the product. By using a portion of the heat contained in the waste gases to preheat the blast in a recuperator, the flame temperature can be raised considerably. This is especially useful when melting steel, as, if the blast temperature is raised between 250 and 300 deg. C., a steel charge can easily be heated up to 1,700 deg. C. in a short time.

### Melting Advantages Summarised.

The metallurgical advantages of the Brackelsberg process may be shortly summarised as follow: Because of the extremely hot coal-dust flame and the continual rotation of the furnace, the melting process is very short. The charge therefore comes into direct contact with the heating gases only for a comparatively short time, and oxidation losses can be almost completely avoided either by using no excess air for combustion or by keeping the flame slightly reducing. As the metal melts it sinks beneath the slag covering, and is then protected by this from any further action of the furnace atmosphere, the outer coating of oxide on the metal remaining behind in the slag. In spite of the fact that the solubility of gases and oxides in iron increases with the temperature, the molten metal can be heated to as high a temperature as desired without any ill effect, providing that there is a layer of slag above it. Heat is transmitted to the metal from above through the slag and from beneath through the heated furnace lining. No large amount of oxides is absorbed during melting, and so the bath does not boil, even if heated to a very high temperature. There are therefore no losses caused by metal spurting up through the slag and becoming oxidised. The flame is never directed on to the bath, and so the slag is never forced back, nor the molten metal beneath exposed. In short, in the Brackelsberg furnace the metal has practically no opportunity of absorbing gases or oxides.

Having now shown that the Brackelsberg process has considerable advantages both from a heating and from a metallurgical standpoint over the other melting processes known to-day, it is now proposed to explain in greater detail how these advantages affect the melting process, and, in particular, the product.

### Deterioration of Pig-Iron.

The pig-iron industry has developed its production, but has not in any way improved the quality of its product. The production of the blast furnace has been increased by building larger furnaces, using higher blast pressures, raising the temperature, and enriching the mixture artificially with scrap, and this has resulted

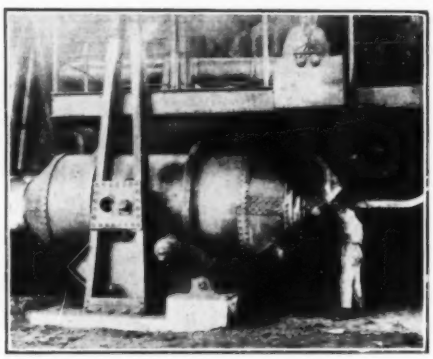

Fig. 4.—The Furnace shown in Fig. 3 during Rotation.

in an increase in the gas and oxide content of the pig-iron. When remelting the metal in a cupola it is impossible to prevent it absorbing further impurities, so that there is grave danger of its becoming supersaturated with gases and oxides and forming large quantities of defective castings. There is much less danger of waste of this kind if the pig-iron is remelted under conditions which prevent it absorbing further quantities of gases and oxides.

### The Phenomenon of Undercooling and Soundness.

In the Brackelsberg furnace the melting conditions are very favourable, and greatly influence the quality of the metal. When cast iron is melted in this furnace it becomes a very thin liquid, irrespective of its chemical composition. From it, castings of very thin section can easily be made. The structure is always dense, and there is no tendency to form internal piping. The probable reason why the metal becomes so liquid is that it can undercool considerably. It is usually found that the purer the melt, the greater the possibility of undercooling. If the melt contains dissolved gases or oxides which segregate during cooling, there is no possibility of undercooling; the first mixed crystals separate out at the proper time, and the viscosity of the metal suddenly increases as soon as the temperature of incipient solidification is reached. If, on the contrary, the melt is practically free of these impurities, the segregation of the first mixed crystals will only commence at a much lower temperature, because of undercooling; in this case the metal will penetrate much farther into the restricted portions of the mould than if solidification commenced at the usual time.

### Reverberatory Furnace Practice.

Cast iron from the Brackelsberg furnace has all the good qualities of a special-grade casting produced in a reverberatory furnace, which is usually used only for this purpose. The strength of grey iron depends primarily on the amount, kind and distribution of the graphite it contains. The distribution largely depends on the melting process. Only when the dissolved graphite crystallises out from a melt which contains no more free graphite will it be possible to obtain a sufficiently fine distribution. In all reverberatory furnaces the melting is comparatively slow, so that the graphite is completely dissolved, and the preliminary condition for fine distribution fulfilled. But in the cupola this is not so, because the melting time is very short and there are many foreign bodies present which have the same action as free graphite and cause premature crystallisation of the dissolved graphite. If fine graphite distribution is desired the molten metal must subsequently be subjected to a special treatment. In the Brackelsberg furnace, as in every reverberatory furnace, there is no free graphite left when the charge has been melted; the melting time is so short and the melting conditions are so perfect that only a very small amount of foreign bodies, which can cause premature crystallisation, and the formation of large graphite crystals is absorbed. The result is that the graphite always separates out very finely.

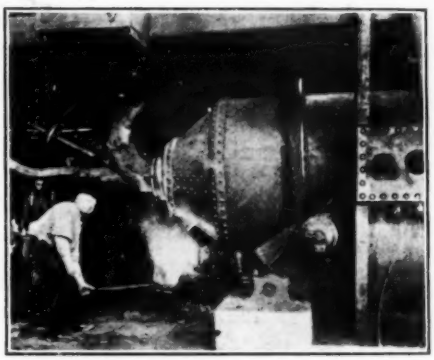

Fig. 5.—The Furnace during Tapping.

### Low-Carbon Content and Casting Properties.

Another important essential for great strength in grey iron is a low-carbon content. In the Brackelsberg furnace, as also in all reverberatory furnaces, any desired carbon content can be obtained. In the cupola, however, if the carbon content is reduced below 3.0 per cent. the metal pours very badly, and this is a distinct disadvantage. It is not due to the fact that the solidification temperature is higher, but to the large quantities of gases and oxides which make the low-carbon metal very impure. Iron from a Brackelsberg furnace has very good casting qualities, irrespective of the carbon content and of the chemical composition; furthermore, it can be heated to any desired pouring temperature without any difficulty.

When producing an alloy in the Brackelsberg furnace, it is just as simple to control the proportions of *all* the various elements as it is to regulate the carbon content. Any special alloys added to the molten metal usually become completely dissolved in between 10 and 20 minutes.

For instance, cast iron can be greatly improved by alloying it with nickel and chromium,

for it is well known that these elements considerably increase its strength and hardness without affecting its machinability. But in the cupola these additions cannot be mixed with the charge, because chromium has a great affinity for oxygen and nickel for sulphur; nor can they be added to the molten metal in the ladle, because neither a sufficiently high temperature nor the sufficient time for them to be completely dissolved. For these reasons there is grave danger of this method of improving cast iron through alloying not being extensively used, in spite of the great possibilities which it offers. In the Brackelsberg furnace, there are no difficulties in adding these elements, as they are simply thrown into the furnace shortly before tapping. There is ample time and the temperature is sufficiently high for these additions to be dissolved completely and distributed uniformly all over the bath.

### Metallic Losses.

It has already been emphasised that complete combustion of the coal dust can be obtained without any excess air, a short flame being formed and the highest possible temperature developed. The flame can also be made slightly reducing without any considerable loss of heat and increase of melting time. In fact, the flame can be regulated so accurately that metallic losses in the Brackelsberg furnace are reduced to a minimum; under normal conditions they should never exceed 1 per cent. Melting conditions being so favourable, it was hoped that it would be possible to remelt fine cast iron and steel scrap, turnings, borings, etc., in the Brackelsberg furnace without unreasonable loss. It must be remembered that the greater the surface area of the charge exposed to the furnace gases the greater the danger of oxidation. It is, therefore, possible to estimate the demands which are made on a melting process when remelting fine turnings, when it is realised that a charge of ordinary turnings or borings has a surface area between 100 and 500 times as great as a charge of pig-iron of the same weight. Several experiments were carried out to test the possibility of using the Brackelsberg furnace to produce high-test cast iron from fine borings and turnings; the results of these are given in the following.

The experimental furnace used had a capacity of 1½ to 2 tons. It is shown in Figs. 3, 4 and 5. As alloys, 80 per cent. ferro-manganese and 40 per cent. ferro-silicon were used. The petroleum coke used was stated to have a low-sulphur content, but it was later ascertained that it contained 1 per cent. sulphur. All test-bars were cast in green moulds.

### Melting Cast Iron and Steel Borings.

*Experiment No.* 1.

The charge consisted of 1,323 lbs. of small steel scrap, 882 lbs. of steel turnings and grey-iron borings, and 66 lbs. of coke in large lumps.

When liquid, the bath contained 2.2 per cent. carbon. After removing the slag, 35 lbs. of small coke were added. This brought the carbon content up to 3.2 per cent. Ten minutes before tapping, ferro-silicon and ferro-manganese were added. The final product was of the following composition: 3.20 per cent. C., 1.91 per cent. Si, 0.71 per cent. Mn, 0.17 per cent. P and 0.13 per cent. S.

*Mechanical Properties.* The tensile strength was 24.0 tons/sq. in., the transverse test gave a modulus of rupture of 35.2 tons/sq. in. with a Brinell hardness of 232.

Fig. 6 shows the etched and unetched samples from this melt. The graphite is distributed extremely finely in the shape of small leaves, and the matrix is pure pearlite.

### Melting Cast-Iron Borings Alone.

*Experiment No.* 2.

The charge consisted of 1,102 lbs. of grey-iron borings and 15.4 lbs. of pea-sized coke. No carbon was added to the molten metal, but 10 minutes before tapping 51 lbs. of ferro-silicon and 13.2 lbs. of ferro-manganese were added. The grey-iron borings were of the following composition: 3.47 per cent. C, 1.43 per cent. Si, 0.63 per cent. Mn, 0.08 per cent. S and 0.45 per cent. P. The final product was of the following composition: 2.93 per cent. C, 2.77 per cent. Si, 1.42 per cent. Mn, 0.43 per cent. P and 0.11 per cent. S.

*Mechanical Properties.* The tensile strength was 21.8 tons/sq. in., the transverse test gave a modulus of rupture of 32.0 tons/sq. in., with a Brinell hardness of 255. Here again the graphite was extraordinarily finely divided, and the structure purely pearlitic, as is shown in Fig. 7. No less than 37.5 per cent. of the carbon present in the charge was burnt off, the greater part undoubtedly going from the coke. Melting losses for silicon were 24.5 per cent. and for manganese 10.3 per cent. This is assuming that all the additions charged became properly mixed with the bath.

### All-Steel Turnings.

*Experiment No.* 3.

The charge consisted of 1,102 lbs. of steel turnings and 49.6 lbs. of coke, but 10 minutes before tapping 88 lbs. of ferro-silicon and 13.2 lbs. of ferro-manganese were added. The tapping temperature was 1,540 deg. C. Fig. 8 shows the graphite distribution and the structure. The product was of the following composition: 2.50 per cent. C., 2.88 per cent. Si, 1.11 per cent. Mn, 0.11 per cent P and 0.11 per cent. S.

*Mechanical Properties.* The tensile strength was 25.7 tons/sq. in., the transverse test gave a modulus of rupture of 38.3 tons/sq. in. with a Brinell hardness of 273. Melting losses amounted to 42 per cent. of carbon charged, and 30 per cent. of the manganese contained in the steel turnings. None of the silicon charged was lost.

In experiments 4 and 5 two transverse tests were made in each case, one with a normal test-bar of 1⅜ in. dia., and another after machining a test-bar down to 1 in. dia., which was found to increase the transverse strength by between 17 and 20 per cent. The reason for this is as follows. The test-bars were all cast in green-sand moulds, and thus the outer part solidified very quickly. This naturally set up strains in the bar, and these would obviously be greater in a high-quality cast iron than in some softer material. By removing the outer part, which solidified too quickly, the internal strains in the bar were diminished.

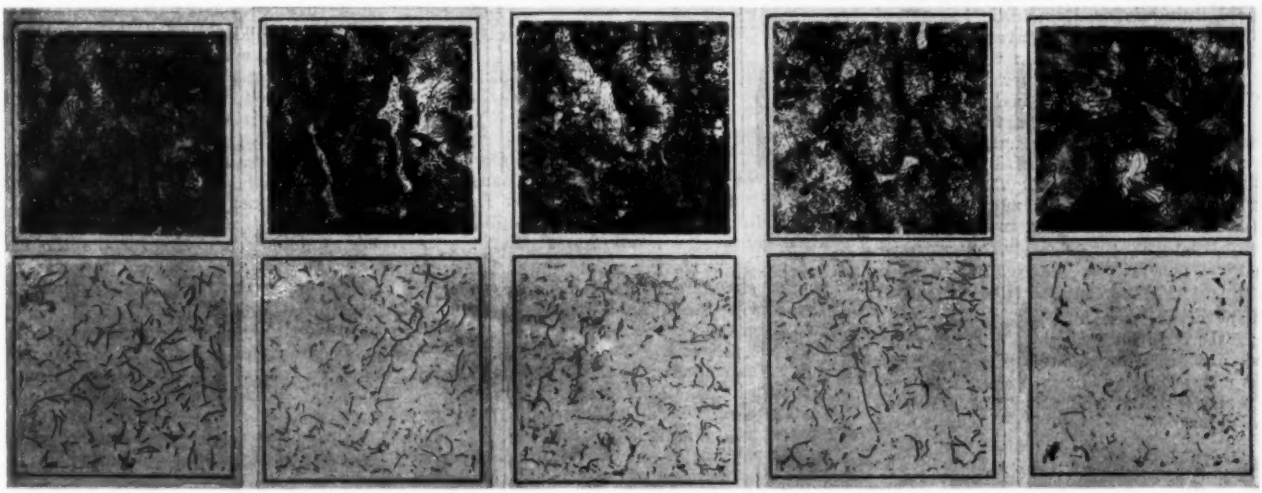

Fig. 6. Fig. 7. Fig. 8. Fig. 9. Fig. 10.

Figs. 6 to 10 show the Etched and Unetched Samples from the Five Experimental Melts described by the Author. (Magnified 100 dias. but reduced 50 per cent. on reproduction.)

### Cast-Iron Borings and Steel Turnings.

*Experiment No.* 4.

The charge consisted of 1,036 lbs. of grey-iron borings, 728 lbs. of steel turnings and 53 lbs. of small coke. The charge was completed with 66 lbs. of ferro-silicon and 13.2 lbs. ferro-manganese. The final product was of the following composition: 2.90 per cent. C, 1.95 per cent. Si, 0.85 per cent. Mn, 0.27 per cent. P and 0.11 per cent. S.

*Mechanical Properties.* The tensile strength was 21.2 tons/sq. in., the transverse test gave a modulus of rupture of 38.7 tons/sq. in., or with the bar machined down 45.5 tons/sq. in., with a Brinell hardness of 248. Fig. 9 shows the graphite distribution and the structure.

The total melting loss of carbon was 41 per cent., the largest part of this being from the coke charged; from the turnings charged about 33 per cent. of the silicon and 44 per cent. of the manganese were oxidised.

### Steel Scrap and Cast-Iron Borings.

*Experiment No.* 5.

The charge consisted of 661 lbs. of small steel scrap, 441 lbs. of grey-iron borings and 66 lbs. of coke. The charge was completed with 33 lbs. of ferro-silicon and 13.2 lbs. of ferro-manganese (containing 47 per cent. Mn instead of the usual

80 per cent.). The final product was of the following composition: 2.92 per cent. C, 1.52 per cent. Si, 0.65 per cent. Mn, 0.19 per cent. P and 0.11 per cent. S.

*Mechanical Properties.* The tensile strength was 24.3 tons/sq. in., the transverse test gave a modulus of rupture of 36.8 tons/sq. in., or with the bar machined down 44.0 tons/sq. in. and a Brinell hardness of 238. The structure is shown in Fig. 10.

In this experiment the exact losses were ascertained; by weighing the charge and also the molten metal, it was found that, taking no account of the metal remaining in the ladles (approximately 1 or 2 per cent.), the metallic loss was 2.5 per cent. The slag contained 7.21 lbs. of iron and 2.23 lbs. of manganese. The total amount of metal converted into slag represented a metallic loss of 0.81 per cent.

These experiments show, therefore, that in the Brackelsberg furnace it is possible under normal melting conditions to produce a high-duty cast iron with excellent mechanical properties from a charge of fine cast-iron borings and small steel scrap or fine steel turnings. Serious oxidation losses need not be feared even if the charge is in a very fine state of division. Normally, when melting turnings or borings, these losses should not considerably exceed 1 per cent.

If an acid lining is used, metallic losses for manganese are very heavy and average 50 per cent. of the amount contained in the turnings and borings charged. About 30 per cent. of the silicon in the cast-iron borings is burnt away, and 40 per cent. of the carbon in the cast-iron borings and in the carburising agent. In all cases the mechanical properties of Brackelsberg iron produced from scrap are good and the casting qualities excellent. The metal remains just as quiescent as iron produced in a Brackelsberg furnace from good pig-iron, and all castings are dense.

### Melting Costs.

A summary of the costs of melting grey iron in a Brackelsberg furnace is given in Table II. The figures are based on a 5-ton plant melting three times a day 250 days in the year, and thus having a yearly melting production of 3,750 tons from 750 charges.

Table II.—*Costs of Melting.*

| | Shillings per ton |
|---|---|
| (1) *Fuel consumption:* 15 per cent. (fine coal, 14s. to 24s. per ton) .. .. | 2.10 to 3.60 |
| (2) *Furnace lining:* 150 charges .. | 0.60 to 0.70 |
| (3) *Power consumption:* drives for fans, mill and rotating motor: 8.0 kw.-hours .. .. .. .. | 0.50 to 0.60 |
| (4) *Wages:* 1 working hour per ton .. | 1.20 to 1.50 |
| (5) *Upkeep of plant, repairs, lubricants* .. | 0.50 to 0.90 |
| (6) *Interest and depreciation on plant* .. | 3.00 to 3.70 |
| Total melting costs, without general on cost .. .. .. .. | 7.90 to 11.00 |

Table III gives the cost of 1 ton of liquid cast iron produced in a Brackelsberg furnace from fine scrap turnings. The product is to be approximately of the following composition: 3.0 per cent. C, 1.80 per cent. Si, 0.80 per cent. Mn, 0.30 per cent. P and 0.10 per cent. S.

Table III.—*Cost of Charge and Total Cost.*

| | Shillings. |
|---|---|
| 1,452 lbs. grey-iron turnings (30s. per ton) .. | 19.80 |
| 660 lbs. steel turnings (30s. per ton) .. .. | 9.00 |
| 66 lbs. of 40 per cent. ferro silicon (£12 per ton) .. .. .. .. .. .. | 7.20 |
| 17.6 lbs. of 80 per cent. ferro-manganese (£12 10s. per ton) .. .. .. .. | 2.00 |
| 77 lbs. of petroleum coke, or old electrodes, or retort carbon (£5 per ton) .. .. | 3.50 |
| Melting costs (average of 7.90s. and 11s. per ton) .. .. .. .. .. | 9.50 |
| | 51.00 |

### Conclusion.

These details should suffice to prove that the Brackelsberg furnace fulfils all the demands made on a modern melting plant for the production of high-duty cast iron. The important advantages from a metallurgical standpoint make it possible to melt down a charge under perfect conditions and produce an iron with excellent casting and mechanical properties from poor quality raw materials. A further result of these advantages is that the chemical composition is under absolute control, which is vitally important for the production and further development of cast-iron alloys.

Finally, as regards the commercial value of this new melting process, there is no doubt that it can compete successfully with all other melting processes because of the low production cost of the liquid iron. Besides this, other economies are effected by production being made more reliable and defective castings eliminated and by the use of cheap raw materials.

To sum up, a high-test cast iron with excellent casting and mechanical properties can be produced at very small melting and operating cost in the Brackelsberg furnace from the cheapest of charges. The Brackelsberg process, therefore, affords an excellent means of developing the use of high-test cast iron, and it is to be hoped that this metal will maintain its foremost position as the most important material used in mechanical engineering.

## Annual Meeting of Middlesbrough Foundrymen.

The annual meeting of the Middlesbrough Branch of the Institute of British Foundrymen was held at the Cleveland Institute on April 11, when Mr. A. G. Harrison was elected Branch-President in succession to Mr. W. Shaw.

The Hon. Secretary (Mr. F. A. Harper), in his yearly statement, reminded those present that in March the Branch had celebrated its fifth anniversary. On March 26, 1926, the Branch came into existence, and Mr. F. P. Wilson, J.P., who was present that evening, was the first President. The 27th annual convention of the Institute had been held in Middlesbrough during the year, and it was fitting that the National President then was Mr. Wilson, who was one of the pioneers of the organisation. The cost of the convention had been in the region of £600, and he was happy to state that the Branch had come out on the right side. He paid a tribute to Mr. N. D. Ridsdale and Mr. W. Shaw for their loyal work in connection with this visit.

Dealing with local affairs, Mr. Harper said that despite difficult times the membership had increased, and it was now 80, and the average attendance at the monthly meetings was 50 per cent. He hoped for an improvement in the coming year. Of the many local works represented in the membership, there was not one of the Darlington foundries, and he hoped that before long they would have members from that town.

The financial statement, presented by the Hon. Treasurer (Mr. T. E. Bashford), showed a credit balance of £26.

Officials for the year were elected as follow:—*President*, Mr. H. E. Harrison; *Senior Vice-President*, Mr. S. P. Thorpe; *Junior Vice-President*, Mr. J. E. Marcer; *hon. secretary*, Mr. F. A. Harper; *hon. treasurer*, Mr. T. E. Bashford. In a vote of thanks to the retiring officials, Mr. W. Shaw's work during his year of office was especially praised.

### The Holley Permanent Mould.

Mr. W. H. Bound, a local member, gave a lecture on "The Holley Permanent Mould," illustrated by a film.

Mr. Bound said that the use of permanent moulds had been a source of study and investigation to foundrymen for many years, and whenever the question of the manufacture of a very large number of castings of the same kind was involved the need for a process using permanent moulds was emphasised. Iron moulds had been used for many years, the most familiar example being the mould for gaggers. The centrifugal-casting process, using permanent metal moulds, was being given international attention.

The chief reason why permanent moulds had not gained a more solid footing in the foundry industry was because molten metal poured into an iron or steel mould was subject to entirely different influences than was the case with the ordinary sand moulds. The rate of cooling was much faster, with consequent more sharply-defined crystallisation effects and production of very fine-grain structure, if not actual chilling of the metal to whiteness.

The principal conditions which had to be considered by the Holley people in developing this process were:—(1) Mould surfaces had to be highly refractory, so that the least possible heat was transmitted inward to affect the form of the mould and in order not to limit seriously the rate at which the moulds can be poured; (2) the nature of the mould material had to be such that no gases were formed during contact with the molten metal until it had set; and (3) mould surfaces had to be sufficiently strong to resist the cutting action of the metal.

The moulds evolved by the Holley Company to satisfy these conditions consisted of light hollow cast-iron moulds, the surface of which was covered with a thin layer of highly-refractory material (practically fireclay), and this refractory surface was protected from cutting and penetration by a thick coating of lamp-black. A novel feature, said the speaker, was that an acetylene-gas flame (which is a very smoky flame) was used to make the carbon or lampblack coating. This coating was relatively thick, about $\frac{1}{32}$ in., and was very quickly applied.

The usual application of these moulds to a repetition line of castings was that twelve moulds were placed on a turntable, which was caused to rotate. In the course of one revolution each mould followed a definite routine. In order to start, the two parts of the mould were drawn apart, and each surface was smoked with acetylene-gas flame, after which the cores were set. Then the two parts of the mould were closed and held tight with spring pressure, after which the mould was poured. The moulds opened quickly and the castings were forced out by ejector pins, whilst compressed air cleaned the moulds.

When a higher rate of production was required, the moulds were cooled on the back with low-pressure air-blast in order to dissipate heat faster. The following figures given by Mr. Bound show the normal rate of production:—

| Weight of casting. | Size of mould. | Hourly production. |
|---|---|---|
| 8 lbs. .. .. | 12 in. × 12 in. | 240 |
| 50 ,, .. .. | 24 in. × 24 in. | 10 to 20 |

The composition of the iron used is C 3.5, Si 2.5 to 2.75, Mn 0.53, S 0.07 to 0.08 and P 0.3 per cent. The usual heat-treatment is to cover in sand and anneal at 870 deg. C., followed by cooling slowly to 535 deg C.

Mr. F. P. Wilson, proposing a vote of thanks to Mr. Bound, said that without doubt permanent-mould casting would develop in this country.

**B.S. Tables of Pipe Flanges.**—The British Engineering Standards Association has published Part 4 of B.S.S. No. 10, Pipe Flanges, which deals with flanges for pressures up to 900 lbs. per sq. in. at a maximum temperature of 800 deg. Fah. Copies of the new Tables (B.S.S. No. 10, Part 4, 1931) may be obtained from the Association, Publications Department, 28, Victoria Street, London, S.W.1. Price 2s. 2d. post free.

# Operating Details of an American Motor-Cylinder Foundry.*

By Arnold Lenz.

The prevalent belief that the foundry industry has not kept pace with rapid developments in other lines is unfounded, and must be attributed to a lack of knowledge of the fundamental principles that control this basic industry.

In 1916 the author was employed in one of the leading American automobile foundries of that day, where they produced about 150 lbs. of good castings per employee. On account of the war, efficiency changed little in the next three years. When the Chevrolet foundry was built in Saginaw in 1919 the goal was set at 200 lbs. per employee. It took until 1922 and 1923 to reach this figure; in 1924 it was raised to 245 lbs. With the introduction of conveying equipment, it was increased to 345 lbs. in 1925 and 1926, to 380 lbs. in 1927, to 425 lbs. in 1928, to 489 lbs. in 1929, and to 585 lbs. in 1930, a gain of approximately 290 per cent. in 10 years.

Expressed in number of employees, the foundry requires at present 5,128 men for peak production. To turn out the same tonnage on a 1916 to 1920 basis would have taken 19,000 men. In other words, there have been eliminated in this foundry 13,872 men in the last decade, and in the same period the output per square foot of floor space increased five and a-half times. The end is not yet in sight, for there are to-day as many improvements ready for adoption, as soon as money gets a little easier, as there were at any time in the past. Reductions in costs have not been so sensational, but in this case they are well under 50 per cent. of what they were 10 years ago.

The organisation is built up along more or less standard lines, but it may differ from other large plants in that there are no assistants, because it is known from experience that assistants as a rule lack the necessary authority to accomplish much. There is no assistant manager, assistant superintendent or assistant foremen. Below the general foreman of a department every man has to be a specialist. This excludes many foundry foremen with a general training, not because they could not become specialists, but because they do not want to be one and resent being tied down to one job. There is so much to be done in a foundry of this size that a foreman can be busy every minute and still cover only a small area.

In order to get material for top positions, the more promising foremen are shifted whenever an opportunity presents itself. This idea is carried even to the higher executives; in order to avoid spreading their interests to a point where their efforts become ineffective, they are given only a limited number of duties for which they are fully responsible. The various departments, of course, have to co-operate with each other, but the whole is co-ordinated by the manager. There is a definite rule that no method, material or piece price can be changed or experimented with without the author's sanction. This avoids duplication of effort without preventing new ideas. If a man has an idea, it is fully considered. If it is old or was previously rejected, the circumstances are explained; if it is a new thought and practical, he receives all possible assistance.

In the modern foundry the pattern shop plays an important rôle, as it is here that a drawing reaches its first concrete form either in the shape of a wood pattern or, in the case of a production job, in a series of tools of which patterns and core boxes may be a comparatively small part. On this account only about 20 per cent. of the pattern-shop force is made up of pattern makers, the remainder being tool makers, machinists and handy men.

A new job is started when the blue prints reach the author's office. After the method of making the work has been determined, the drawings are turned over to the lay-out men who put the job, including all drafts, shrinkages and other allowances, on sheet aluminium. For this purpose there are four face-plates in one corner of the pattern shop, and the four best and most loyal pattern makers have gradually turned over to them all lay-out and templet work, so that to-day no blue print, and seldom a lay-out, ever gets out into the metal pattern department. This line-up has proved efficient where tool-room precision and interchangeability are required.

### Patterns and Core Boxes of Cast Iron.

In order to get at least one year's production from a set of patterns, it has been found necessary to make all patterns and core boxes out of cast iron with a Brinell hardness of about 200. This is considerably harder than iron usually used for this purpose, but the extra cost of working fairly hard iron as against soft iron is negligible if electric flexible-shaft grinders and scrapers are employed, and not at all in ratio to the difference in wearing qualities. A soft iron with large graphite flakes becomes pitted in a short time.

Long, loose pieces in core boxes that have to be hammered, or are likely to break if dropped on the floor, are made of manganese bronze, which is stiff and has excellent wearing qualities. For the sake of accuracy, none of the cores is bedded with sand and all of the shell driers are made of aluminium cast as closely as possible to actual size in order to take a minimum amount of scraping, the joints, as a rule, being ground on Blanchard grinders. The trick of making a shell drier at low cost lies in the care and study given the shell pattern and the care in moulding.

Much of the automobile foundry's success depends on efficient operation of the core room. There is a difference of opinion in regard to how far a core room should be mechanised to be classed as modern. Should a core room include in its equipment, apart from core machines and mechanical core mixers, mechanical sand distributors, mechanical continuous core ovens and conveyors for delivering cores from one place to another and to the foundry? Just wheels have never made anything modern. Results, either in improved and more healthful working conditions or increased dividends to stockholders, are the only determining factors.

Aware of the trend toward continuous core ovens, mechanical sand delivery and core conveyors, the firm has adopted none of them in the new core room. The reason is that for the special purpose the possible returns on such installations did not warrant the investment and, in addition, instead of improving working conditions, the extra structures would shut out light and air. Even if they did not make working conditions worse, in no case did they improve them.

Unlike a foundry making fittings or similar castings, an automobile foundry has a great variety of cores, both in size and cross-sections, that may vary in baking time from 1 to 5 or 6 hrs. Therefore, it is next to impossible to assemble enough cores around any size of continuous oven without having a considerable percentage either over- or under-baked. This applies to either horizontal or vertical ovens. There are a number of vertical ovens which have proved satisfactory for drying blacking, or paste on dried or assembled cores. They are portable and form part of the assembly line, the cores being put in on one side and taken out on the other. Being vertical, they require little floor space; of small capacity, they can be used for one kind of cores and the speed adjusted accordingly.

### No Core Storage Provided.

Although the foundry uses approximately 883,000 cores a day, no stock is carried and no room is allowed for storage beyond a working float between operations. At the end of a cleaning or assembly line, the cores are loaded directly on to a rack, which is removed to the foundry as soon as it is loaded. There it is put directly behind the core-setter, who can reach the cores without re-handling.

To avoid being held up by a shortage of core makers during the rush season, a great deal of study is given to the core boxes. Most of the cores are made on machines by what a jobbing foundry would call handy men. There is no free-hand venting, all vents being located in the core boxes or placed on jigs. On horizontal or slanting vents, the vent wires are guided by long, hardened bushings, which are replaced as they show wear. By this method even the most awkward novice can jerk out a vent wire 2 ft. long without getting $\frac{1}{32}$ in. off its true line. In the case of vertical vents, as in small cores made in multiple boxes, all vent wires are placed on an aluminium frame and pushed in at one time, locating the vents by guide pins longer than the vent wires themselves.

A similar system is followed in placing the core wires, which are accurately cut and bent in a special department and delivered to the core makers. At a production of 6,500 jobs a day, the foundry requires approximately 929,000 core wires, which makes the employment of automatic wire cutting and bending machines practical.

### Sand-Handling System Essential.

The greatest change in the industry has taken place in the foundry department, and the end is hard to foresee because each new development seems to lead to new opportunities. The mechanical sand-handling and conditioning system, mould conveyors and casting cooling conveyors have become firmly established in the modern foundry, and it takes no prophet to foretell that within a few years even the smaller foundries will find a sand-handling system as much a part of their equipment as a cupola. This idea might seem impractical to those who are using two or three or more grades of moulding sand to suit their variety of castings. Competition may force some of these foundries into more specialised lines, but experience shows that one grade of sand may take a much greater variety of castings than is generally believed possible. This is especially true of synthetic moulding sand. All the moulding sand used is built up from waste core sand.

Generally speaking, large conveyor units are favoured instead of a number of smaller ones. There are two sizes—eight are 240 ft. long and six are 140 ft. long. Both sizes are equally successful, but the costs are somewhat in favour of the larger units. The large conveyors can handle as much as 175 tons of iron in 9 hrs., and the foundry is running as high as eight different jobs on one of them. The smaller ones are just about half the capacity of the larger ones, and can handle as low as 9 tons of small castings. All conveyors to-day are built too light. All at Saginaw have extra-heavy chains and drives, but everything points to improved

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* Extracted from a Paper presented at the recent convention of the Michigan Engineering Society at Saginaw, Mich., as reported by the "Iron Age." The author is manager of the grey-iron foundry of the Chevrolet Motor Company.

operation through still heavier construction, and the management has decided to try it on the next conveyor by doubling up on everything.

With the exception of the jobbing and apprentice section, all moulds are made on machines in cast steel flasks. For the sake of simplicity, speed, and greater accuracy in the castings, no gaggers, nails, or bottom boards are used. Venting of moulds has almost been eliminated; where necessary, however, venting is done with a special fixture which assures accurate placement.

Practically all cores are set through metal fixtures and checked in the moulds with templets, which are located from the pin centres. The cores are cleaned, ground, and inspected with templets in the core room; no moulder is allowed to file or scrape a core in the foundry. All castings are poured through strainer gates. No risers or flow-offs are used on any production castings, as it was found some time ago that that was not only unnecessary, but actually a detriment.

### Tendency in Melting is towards Duplexing.

Since the introduction of hot blast, there has been no new development in grey-iron melting equipment which is of general application. There seems to be a tendency toward duplexing with the electric furnace. There is a benefit where small quantities of special or pearlitic irons are required, but, under ordinary circumstances, it is an unnecessary expense, because the limit of cupola iron has not yet been reached.

The basic reason for using cast iron in such large volume is its nature and price. It will always be employed where weight, rigidity and vibration absorbing qualities are necessary. In most cases users object to a slight increase in cost for refining, beyond melting the iron in the cupola. It is one reason why the high-test irons are not more commonly used. Outside of a few special applications, nobody wants to sacrifice cutting speed or pay more.

There has been great improvement in ordinary cast iron (under 16 tons tensile) over the last five or six years. The firm has learned to produce it consistently within close limits in Brinell hardness, tensile strength and machinability. Until a few years ago the poor wearing quality of a cylinder was due to the great difference in hardness between the projecting flanges and the cylinder bores and valve seats. The flanges had to be machined and therefore controlled the hardness of the bore. By the proper selection of raw material, these two extremes have gradually been reduced to a point where a block can be machined at 90 ft. a min. with a bore that does not exceed 0.002 in. wear in 20,000 miles, even under the most severe conditions. Since this has been accomplished through finer and denser-grained iron, spongy bosses and leaky sections have been practically eliminated.

When engineers a few years ago began to insist on harder and stronger iron with better machinability, it was found that high temperatures were an important factor in obtaining results. The author has maintained for years that much good pig-iron was ruined in the foundry, and much poor pig-iron could be improved by hot melting in the cupola; for that reason he gradually raised the temperature to about 1,565 deg. C. at the spout. There are still higher temperatures possible, but this is about all the present cores and moulds will stand, as the present system does not lend itself readily to cooling the iron before pouring.

There has been remarkable improvement in the quality of coke, especially in speeding up combustion. This factor is considered important. One is now able to melt easily 24 tons an hour in a furnace rated at 17 tons; when recently extra iron was needed this was pushed up to 30 tons an hour without impairing the quality of the iron.

### Coke Ratio Raised.

Apart from increased speed, the management has also been able to raise the coke ratio. A few years ago iron with a temperature of 1,480 deg. C. at the spout and a coke ratio of 6½ to 1 was considered good for an automobile foundry; to-day with a temperature of 1,565 deg. C. at the spout the coke ratio is 8.6 to 1. It is realised that still higher coke ratios are possible, but it is felt that the benefits of high temperature will more than pay for the extra coke.

Mechanical charging of cupolas has become established, but care should be taken in selecting proper equipment. The even charging of coke and iron is a requisite, but the equipment should permit the charging of any kind of available raw material; otherwise it can easily become a liability.

In 1916 all cylinder blocks and heads had to be left in the mould from 9 to 11 hrs. before shaking out to prevent cracking. To-day all castings are shaken out red or white hot without any bad effect. This alone shows the big change in this type of iron in the last 14 years. Ability of the present iron to withstand sudden and unequal temperature changes has practically eliminated cracked heads and blocks in automobiles. To handle these hot castings the management has provided a system which cools the castings on the way to the cleaning room. Cylinder blocks are still red hot when the cores are knocked out with a vibrator, are black hot when they come out of the first sand-blast, and many of them are still too hot for the bare hand when they reach the shipping dock, although en route they have been ground, chipped, water-tested, sand-blasted again, and inspected.

### Effect of Rapid Mechanising.

Rapid mechanising of foundry operations has had quite an effect on the maintenance organisation. Several years ago the maintenance could be handled by a few good pipefitters and millwrights, but to-day it requires an engineering department and the leadership of trained engineers. Unlike some other branches of industry, a foundry occupying the front rank has to develop the greater part of its new equipment at least to a point where it can be turned over to some equipment builder, and, to accomplish this, a thorough knowledge of foundry operations is necessary. Due to the sand, dust and hot iron which are ever present, the wear on equipment is heavy; to keep it in running order, the maintenance personnel comprises about 7½ per cent. of the force. Through strengthening of weak parts and the use of dust-proof ball or roller bearings, equipment is being constantly improved, but much is still to be accomplished before it is as free from breakdowns and interruptions as in some other industries.

In the last two years much thought has been given to ventilation, and conditions have improved materially. General ventilation of foundry buildings does not answer the purpose any more. The old system which depended on the smoke and gas going out through the roof in most cases did not help the men employed at a shakeout or pouring station, because the smoke had to pass them to get up to the roof. It is found that every smoke- or gas-producing point has to be isolated and treated separately. Fresh air must be brought directly to the spot where it is required, and should be in direct proportion to the amount of air removed by the exhaust system. If this is not done, some of the blowers will draw on each other, especially in cold weather when windows are closed and ventilation is needed most. Except for a few pouring and shakeout stations, all incoming air should be heated during the winter months.

The ventilating engineer's knowledge is inadequate when it comes to ventilating a foundry, and practically all the real improvements have been made by sitting in the middle of the smoke and gas and figuring the thing out piecemeal. The greatest difficulties come from the changing air currents and drafts caused by the changing winds out of doors. A ventilating system may work well to-day with the wind from the north and be almost useless to-morrow with the wind from the west.

If the author had to lay out a new foundry he would have no moving sash, would close everything tight, and bring in all fresh air through blowers to where it is needed. In this way the exhaust systems would not be affected by constant cross-currents and, on a day when the air is heavy, the exhaust gases and smoke would not come back into the plant through the windows as they do in most large foundries to-day. The tendency, as a whole, is towards cleaner foundries, and it has been proved that it is possible to make a foundry just as clean and the air as clear as in most other manufacturing plants.

There are many parts rightfully belonging to the foundry which to-day are being made in forgings and pressed and welded steel only because the designer was willing to reduce his design to its simplest form in order to come within the limitations of the forge or press. Yet as soon as a casting is substituted, the same engineer will let his fancy roam, and suggestions or protests from the foundry receive scant notice, because he knows that, through the great flexibility in foundry operations, the casting will somehow be produced.

Many of the innovations and short-cuts are possible only because the Chevrolet engineering department has become "foundry-minded" and designs no castings, even for experimental purposes, without taking the foundry into its confidence. This co-operation is well illustrated in the manufacture of a part formerly made in two pieces, part casting and part pressed metal. Last year it became evident that this design lacked the necessary rigidity, so it was decided to replace the sheet metal with a full grey-iron casting on the basis that improved performance would be worth the extra cost. The original design suggested a procedure that would have been followed by 99 per cent. of the foundries, but, after analysing it, it was found that by a change one could save perhaps 9d. a casting. The engineering department redesigned the job, and the foundry had already started production patterns when a new method, not heretofore practised in the foundry, was suggested. The engineers were reconsulted, and as the change did not affect the machine shop they revamped the design. By spending about £200 for rebuilding some obsolete moulding machines, it became possible to reduce the cost an additional 1s., which on a production of a million cars a year means a saving of £36,000 from the first to the second change and £48,000 from the second to the third. Moreover, the third change brought the cost below the original sheet metal part.

There have been many arguments regarding the practicability of large foundries. Many seem certain that its advantages are lost through lack of attention to the innumerable small details which must be observed. The author would not hesitate to recommend doubling the plant if the demand for castings warranted it, because he knows that he could not only hold down the cost, but also open up new sources of saving.

There are, of course, definite economic limitations, such as location, which prevent growth long before the maximum resources of good management are reached. For years the site at Saginaw was a limiting factor, as it was on the north end of the automobile building district, and all of the iron and coke had to be brought north through Detroit, Pontiac and Flint and returned by the same route as finished castings. Behind the plant is the Saginaw River, which was navigable in the days when Saginaw was

the largest lumber-producing centre in the world. By constructing a dock a year ago and getting the War Department to clean out the channel, the directorate has been able to make the location a strategic one. Where formerly they had to pay 10s. freight on a ton of pig-iron from the nearest furnace at Detroit, they can now bring iron from as far as Buffalo for little more than a transfer charge in the city of Detroit. Apart from lower freight, it also permits them to go into other iron markets, such as Cleveland, Buffalo and Chicago.

In an effort to reduce freight costs, the management is constantly on the look-out for raw materials closer to Saginaw or in otherwise more desirable locations. In this search it is aided by a thorough knowledge of all the raw materials used. Everything has to hold its own on the basis of best results at the plant and at the lowest cost per lb. of good castings. No new material is adopted or even considered unless it stands this test. It goes so far as to shift necessary ingredients from one material to another in order to eliminate an extra source or to enjoy a lower freight rate.

### Necessity of a Cost System.

Due to the great quantities of material consumed and the millions of dollars spent for wages in the course of a year, items that are treated as insignificant in a small foundry assume great importance, thus making a cost system necessary. On the basis of a million cars a year, one must produce 245,000 tons of good castings. That means that one must buy 245,000 tons of iron and scrap. If one can save 5d. a ton on the price, the freight or handling, or on all three put together, it saves £4,900. The firm uses about 100,000 tons of coke and 122,000 tons of core sand annually; even ½d. a ton saved on these two items amounts to £450.

At the operating end one has the same results. Fivepence a ton less on labour totals £4,900. Lowering the cost of a cylinder block 5d. amounts to £20,000. When the scrap losses are reduced 1 per cent. a saving of £35,000 a year is yielded, and a decrease in the core scrap of 1 per cent. means a saving of practically £7,400.

At the beginning of every season a cost estimate is made for the coming year, which is consolidated with other manufacturing costs and used as a basis for pricing the cars. A cost for each casting, a standard for productive and expense labour, and a standard for productive and expense material, is set. Last year, as a standard for 1930, the cost of the best month in 1929 was taken. Knowing that these figures were obtained on a high tonnage and that the management was facing a high overhead due to reduced tonnage during the depression, they went over every operation and every material, with the result that, even under worse business conditions than they had anticipated, they were able to reduce their cost considerably.

## Lancashire Junior Foundrymen.

Mr. W. West, of Leyland, addressed a recent meeting of the Junior Section of the Lancashire Branch of the Institute of British Foundrymen on the subject of "What a Foundryman Should Know about Metallurgy." By the simple analogy of a solution of salt and water, he explained the absorption of carbon by iron in the blast furnace and then in the cupola, and its deposition upon cooling, the size of the graphite being dependent upon the rate of cooling. A series of photomicrographs, ranging from pure iron and steel to cast irons, enabled the speaker to illustrate how the appearance of iron under the microscope altered with increasing carbon content. He closed his lecture by outlining the effect of silicon upon the carbon present.

After the discussion, a vote of thanks was accorded to Mr. West, proposed by Mr. R. Yeoman and seconded by Mr. J. Pattinson.

## Scottish Founders' Annual General Meeting.

The annual general meeting of the Scottish Branch of the Institute of British Foundrymen was held in Glasgow on March 21, Mr. James Miller, Branch-President, in the chair. The annual report was presented by the honorary secretary, and the chairman proposed its adoption. This was seconded by Mr. H. W. Winterton, and unanimously carried. An extract from the report is set out below.

### Annual Report.

There is much in this report to give cause for satisfaction. Industry is passing through a period of world-wide depression of almost unexampled severity, and, in common with all others, the foundry industry in Scotland has suffered seriously. Money is scarce; many people have had to find some means of cutting down their expenditure, and, as a result, membership of many societies, in some respects similar to the Institute, has shown a steady decline. On the other hand, our membership has not fallen. It has even increased slightly. It is noteworthy that the increase is most marked in the higher grades of members and associate members, the number of associates being now at the lowest figure for many years past. It is true that the number of admissions during the year is only about two-thirds of what it was in the previous year, and the increase in membership has been made possible only by the reduced number of resignations and names struck off for non-payment of subscriptions. The decrease in the number of admissions is the only disquieting feature, and it suggests that the membership could be much higher if only the members would each try to get even one additional member.

One member was removed from our number during the session by death. Mr. David King had been a member of the Institute since 1914, and although not a frequent visitor to the Branch meetings, he took a keen interest in all our work, and was ever ready to lend a helping hand when anything special was being done to advance the interests of the Branch. To Mrs. King we extend our deepest sympathy.

The Papers submitted during the session were nearly all of a practical nature, and the increased attendances would appear to indicate that this type of Paper appeals to members. The chief difficulty in providing more of such Papers is the reluctance that so many of our practical members have in helping in this side of the work. The Council in their endeavour to appeal to all the interests of the foundry industry have made repeated attempts to get practical Papers, but it is only on rare occasions that success in this direction has been achieved. This session an effort was made to introduce a practical problem at the close of each meeting, and a lead was given by the President, who appealed to others to come forward with problems. Only one offer was made, and it was from a Past-President. This is an interesting sidelight on the difficulties of getting practical Papers.

Last year's report referred in somewhat gloomy terms to the prospects of the Junior Section. The fears then expressed that it could not last much longer have unhappily been realised, and the Junior Section is no more. The office-bearers did their best. We can only thank them for all the efforts they made under difficult and adverse circumstances, and hope that at some other time the Section may be resuscitated to a life of greater length and service.

A Diploma of the Institute once again has been awarded to a member of the Scottish Branch, the recipient on this occasion being Mr. T. M. Service, whose Paper on "Steel Castings" was thus recognised by the General Council. The diploma was presented to Mr. Service at the Branch meeting on December 6, 1930, by Mr. F. P. Wilson, J.P., President of the Institute, who, with Mr. Makemson, the General Secretary, visited the Branch that day.

An interesting date in the history of the Branch was reached on February 16, 1931, when the 21st anniversary of its formation was reached. Arrangements are at present being made for the adequate recognition of this occasion, and, to enable the General Council of the Institute to participate therein, the date of this recognition has been fixed for April 17. One thing, however, may be said. The formation of the Branch was due more to the efforts of Mr. A. Campion than of any other man. He inspired it at the beginning; he has laboured unwearyingly on its behalf ever since; and today in the arrangements for the due celebration of its "coming of age" he is still taking a leading part, to the great satisfaction of all the members of the Council. The time has not yet come adequately to express the appreciation which is felt for Mr. Campion's services, nor the contribution which the Branch has made to the advancement of the foundry industry in Scotland; but to direct the attention of the members to these things is to point out to them the advantages of their membership.

The financial statement for the year ending December 31, 1930, was also adopted.

### Election of Officers.

Mr. N. McManus, M.B.E., was then elected Branch-President, and Mr. H. D. Campbell and Mr. John Currie were elected Senior and Junior Vice-President respectively. Messrs. Robert MacNab, H. Hurst, M. Russell and R. D. Lawrie were elected members of council in place of Messrs. A. Black, J. Currie, J. McNab and H. D. Campbell. Messrs. Jas. Affleck, B.Sc., J. W. Donaldson, D.Sc., James McArthur and H. D. Campbell were elected representatives to the general council, and Mr. John Bell was re-elected hon. secretary.

The newly-appointed Branch-President proposed that a vote of thanks be accorded to the office-bearers and members of council who retired at this time. He felt sure that every one of the members appreciated the services which they had rendered during their term of office. Mr. J. Longden seconded the motion, which was carried with acclamation. The President said he was sure that the members would wish for an expression of thanks to be passed to the Royal Technical College authorities, for their courtesy in allowing them the use of the rooms free of cost. He suggested that the secretary should be instructed to send a copy of the resolution to the Secretary and Director of the College. The motion was agreed to.

The President referred to the coming-of-age celebrations, and intimated that the Corporation of Glasgow had agreed to extend civic hospitality to the members and their friends on April 17. He pointed out that this was an unusual honour, and appealed to every member to make a special effort to attend. He also appealed to every member to do his utmost to obtain at least one new member, as the real object of the celebrations was to secure publicity for the work which they were doing for the industry and the extension of membership of the Branch. The council were arranging for the marking of the anniversary in other ways which would be announced in due course.

A vote of thanks was accorded the auditors for their services. Following the annual general meeting, Mr. D. R. Tullis presented his Paper on "The Use of Refined Metals in the Foundry."

At a conference of Cleveland ironstone mine-owners' and miners' representatives, at Middlesbrough recently, the miners agreed to accept a 4½ per cent. reduction in wages for the second quarter of the year. Under the sliding-scale arrangement the owners were entitled to a 7½ per cent. reduction.

# The Production and Supply of Foundry Pig-Iron.

At the March meeting of the Lancashire Branch of the Institute of British Foundrymen, held in the Manchester College of Technology, the chair was taken by Mr. E. Flower (Vice-President), in the absence, through indisposition, of the Branch-President (Mr. R. W. Stubbs). Major H. G. Scott, of Middlesbrough, presented a Paper upon "The Blast Furnace, its Limitations and its Relation to the Cupola."

### Supervision of Raw Materials.

Major Scott, by means of a model of a Cleveland furnace, outlined the fundamental principles underlying blast-furnace practice. His later remarks were designed to postulate the limitations of the process, and from this section we have extracted the chief points. He said that although the raw materials in the blast furnace may differ in composition from hour to hour, they are supplied in carefully-calculated proportions, and unless the furnace operator knows exactly what the materials contain he cannot calculate his burden. He requires, therefore, the assistance of the analytical chemist and he requires him day and night and from hour to hour, not only to tell him what he is putting into the furnace, but what he is getting out. One can easily conceive that the more regular the materials are in their composition, the easier the process becomes. But one cannot depend upon that regularity, so that the supervision must be constant. Analytical tests are reduced to a definite routine calculated to enable the operator to make timely alterations in the furnace burden.

The duty of a blast furnace is to make *saleable* iron; nothing else will do. The safest way to do this is to aim at a definite grade of iron which one knows the raw materials will make and endeavour to produce that grade every time and all the time. It will not always be done, and it is the duty of the operator to keep the limits of grading as small as possible. The longer he keeps on a similar burden the more exact his results are bound to be. He can deal with small fluctuations better than large ones. Nothing is more detrimental to the economical working of a furnace than violent changes of the burden. The furnace has often been likened unto a human being: it acquires habits. Nothing satisfies an operator more than when his furnace acquires a good habit, and in a furnace, the same as in a human being, good habits should not be needlessly interfered with.

### Function of the Blast Furnace.

The iron the blast furnace produces is graded by its impurities, which consist of (1) carbon, (2) phosphorus, (3) manganese, (4) silicon and (5) sulphur. There are traces of other substances, which for the present may be neglected. The first three may be considered as uncontrollable, and the control of the last two constitute the ultimate object of the operator. Carbon exists in iron in two forms—graphitic and combined—and the sum of the two is practically constant in the grade of iron one is making. Phosphorus is also constant and depends entirely on the amount in the burden. The whole of the phosphorus in the burden goes into the iron; the furnace eliminates none of it. From 40 to 60 per cent. of the manganese in the burden goes into the iron.

Within limits, the silicon and sulphur can be more or less controlled, but the conditions must be favourable. The flux supplied to the furnace is calculated to control the silicon, and should take the sulphur in its stride, so to speak. If extra limestone is added to control the sulphur, the whole of the operator's calculations may be seriously upset. Experience has shown that sulphur up to 1 per cent. in the coke is controllable. If, however, it approaches 1½ per cent. it is almost impossible to remove it in the slag.

### The Blast-Furnaceman's Opinion of Foundry Requirements.

There is an old saying that appearances are sometimes deceptive, and the appearance of the fracture of pig-iron is very often deceptive. After making pig-iron for thirty-four years, the author feels himself entitled to say something about its fracture. From the appearance of molten iron running down the pig-bed he can tell almost to a decimal point what the silicon and sulphur contents are, and very much more exactly than he could by the fracture. The fracture largely depends on how the iron is cooled, and one can produce at any time pig-iron exactly similar in all respects as to its chemical and physical composition with a totally different appearance in fracture. The whole of this apparent difference would disappear when the iron is remelted in the cupola. The only really dependable thing about pig-iron intended to be remelted is its analysis. All that the blast furnace can do is to produce, within limits, iron of a certain standard grade, and that is all that the foundryman should expect. To attempt to do otherwise would only end in chaos. Foundrymen should know the analysis of the iron they require and then proceed to get it.

The way he should go about it is to procure an iron which in its standard form should approach as nearly as possible the grade he requires, and then, by judicious mixture in the cupola, attain his requirements exactly. If he cannot do this in a cupola, and his requirements are exact, he should have recourse to an air furnace or refining furnace. The subject of cast iron is a very complex one, as complex as steel, and a steelmaker depends entirely on the analysis of his product in his research work. If the foundryman desires to compete with the steelmaker and produce castings of quality and strength, combined with a minimum weight, it is difficult to see how he is going to do it unless he emulates the steelmaker and goes in for very exact results, which are only to be obtained by careful and laborious research. There is a great future for the cast-iron business in this respect.

### Refining by Superheating.

The confidence that is placed in scrap by founders, no matter where it may have come from, has always been a mystery to the author. There is one warning, however, that he would like to utter. Cast iron, remelted many times, has a bad habit of generating ferrous-oxide which is more or less irreducible in the cupola and tends to make castings brittle. As an example of what may be done in refining, it has been found that when iron is heated to 100 deg. C. above the melting point, and allowed to remain at that temperature, say, for an hour, the graphitic carbon is much better distributed in the resultant casting, indicating a more homogeneous substance. The strength of cast iron demands much research.

### A Jumping-off Point.

As a starting-point, the strength of test-bars made from 50 per cent. of No. 3 Cleveland pig-iron and 50 per cent. of scrap—the scrap consisting wholly of railway chairs—should be in the neighbourhood of 14 tons per sq. in. If this subject were carefully investigated, the tensile strength of cast iron could be very much improved beyond present knowledge. An example taken from personal experience of how iron was blamed for a result simply for want of care and supervision presents a point of interest. A certain foundry was making baths and using Cleveland iron. A complaint was made that they could not obtain a smooth enamel surface. The enamel had a blistered appearance when finished, and the only conclusion which could be arrived at was that the iron was at fault. Samples of the bath castings, one with a good enamelled surface and another with a blistered or rough surface were obtained. After careful analysis of both samples, it was found that the iron was quite normal; indeed, the users had no fault to find with it. They also stated that the bath, when being enamelled, was heated to 900 deg. C. Microphotographs were taken of the sections of the samples obtained, and it was found that the structure, which should have shown a lamellar formation if it had been heated up to 900 deg. C., showed a globular formation, which is fairly conclusive proof that they had been mistaken in the temperature of their furnace and the bath had not been heated sufficiently to degasify the enamel. Hence the blistered appearance of the surface.

### Points in Foundry Practice.

Why does a foundryman accept pig-iron that has been cast in sand and which has, adhering to its entire surface, sand which may mean anything from 1½ to 2½ per cent. of silica in its worst form and which must be removed in the cupola? The up-to-date steelmaker refuses to consider any iron cast in sand. He demands an iron with as clean an outside as inside, because he says he then knows what he is getting. He demands his iron cast in chills. This, of course, entirely upsets the fracture, of which he takes no notice whatever.

Again, why does not the foundryman decline to take his iron broken into pieces suitable for his cupola men to handle? Most of the foundry iron in America is cast in a machine and in convenient size and weight for an average man to handle, little or no notice being taken of the fracture which is entirely altered by quenching.

### Conclusion.

The foregoing remarks outline the limitations of the blast furnace and suggest that, beyond the standard product he makes, the blast-furnaceman cannot help the foundryman. It has also been suggested that there is a great future before the foundryman to be obtained by scientific research into the mixing, blending and heat-treatment of his material.

### Vote of Thanks.

A vote of thanks to the author was proposed by Mr. J. S. G. Primrose, who said that Major Scott's Paper might be described as a basic lecture upon blast furnaces; it was a very enlightening one. Major Scott had taken them into his confidence and shown them that foundrymen must rely upon themselves. Their business was to make good castings out of any kind of pig-iron. There was no bad pig-iron; the way in which the foundrymen used it decided whether or not good castings would result. That was an opinion which quite a number of people held, and he thought Major Scott had proved it. There was matter for considerable discussion. Mr. R. A. Miles seconded the vote of thanks, which was passed unanimously.

In acknowledgment, Major Scott said he would like to see between the foundrymen and the blast-furnacemen the same relationship and fellow-feeling which existed between the steelmakers and the blast-furnacemen. His experience was that, unfortunately, foundrymen did not come to the blast furnace to talk over things. In the thirty-four years in which he had made pig-iron, not one of them did so. Their views about pig-iron were brought to him, but that was the beginning and the end of the matter. That state of affairs was wrong. They ought to come together and discuss things; mutual benefit would certainly result. The blast-furnaceman knew what he could give the foundryman. If the foundryman would say what changes he wanted, the blast-furnaceman would try to alter things accordingly.

### DISCUSSION.

Mr. A. Sutcliffe said the small foundry could not make a profit if it had to carry too many

brands of pig-iron, but the metallurgist told them it ought to do so in order to do the work efficiently. Another metallurgist then assured foundrymen that they could make any kind of casting from a No. 3 pig-iron if they added a little of his own proprietary brand. Major Scott had referred to white iron for mixing purposes. They had been given to understand that white iron was a freak, and also a nuisance to the foundrymen. Could it be used in mixing different kinds of iron?

### Making Pig-Iron in Iron Moulds.

During the last five or six weeks he had had the experience of using Indian iron or Burn iron, which was cast in iron moulds. He liked it because his castings had shown up very well in the machine shop. He had only two brands in the mixture—one used with the Burn pig-iron. With pig-iron cast in an iron mould one received all pig-iron and no sand. He was very glad Major Scott mentioned the notching of pig-iron. It was a great help to cupola attendants. A few months ago he had an experience with a Midland pig-iron. When this was melted and poured into the shank, a froth or "kish" came to the surface, and when this was skimmed, more "kish" would appear.

They had been told by Mr. Cameron that if they mixed steel and cast iron together no chemist could tell the amount of steel used. He (Mr. Sutcliffe) knew of many cases where nickel had been put in but not found in the analysis. He would like to know Major Scott's opinion of "doping" the iron so much as some people were advising. It seemed to him that these things were put forward by men who were just out to get a living. First low-carbon, then semi-steel and nickel; one or two more were coming along; but in the end foundrymen had to pay the piper.

In the Manchester area iron was being made in which about 75 per cent. of the mixture was scrap. Foundrymen ought to know where they stood when considering such types of pig-iron. A good deal could be said in support of the statement made to him by a foundry manager: "If you adopt the ordinary way, that of the old fellow in the years gone by, you will get good results: 'Buy good iron.'"

### The Use of White Iron.

Major Scott said the whiter the iron the higher would be the percentage of combined carbon. Up to 1 per cent. strengthened the casting; above 1 per cent. it did not. If the combined carbon was controlled and brought below 1 per cent. and mixed with siliceous iron, he saw no reason why they should not get from those two grades which were mixed an iron which was a mean of the two. He could not advise about the necessity or otherwise of a small foundry having four or five brands of pig-iron. It was the foundryman's business to find out what was wanted and how to get it. He was glad to hear that Mr. Sutcliffe looked favourably upon iron cast in chills and not in sand. Personally, he did not see why the foundryman should not have his iron clean. It might be that sand on the pig-iron produced a better slag in the cupola. He had been told that it preserved the cupola lining. "Kish" was, of course, graphitic carbon. It would make the iron soft and the castings soft. It was the distribution of the graphitic carbon in the structure of the pig-iron that was important. In a very open pig-iron one found the streaks of carbon were very much larger in the centre than at the sides.

### High Temperatures and Pressures.

Mr. W. West (Leyland Motors, Limited) asked whether it was a general practice now to run higher temperatures and pressures in the blast furnace than were usual ten or fifteen years ago. He had heard many complaints from different foundries, especially those occupied in the manufacture of cylinder or pressure castings, that certain of the old and well-known brands of pig-iron did not produce the solidity in the sections as they did some years ago. While such complaints were vague, it was a very noticeable fact that, while many blast furnaces were producing unprecedented tonnages for any given time, the use of refined irons of one kind or another was growing tremendously. If it was a fact that many blast furnaces had adopted an intensive production by increasing the temperature and pressure of the blast, two sources of trouble might have been introduced: firstly, an increased total-carbon absorption, due to the higher temperature; secondly, an imperfect reduction of the ore causing a higher percentage of ferrous oxide in solution in the pig-iron. From a steelmaker's point of view there existed a definite connection between the amount of ferrous oxide and other oxides left in the steel and the degree of shrinkage and gas holes in the solid metal.

Major Scott replied that he did not think there had been any great change in blast-furnace practice making foundry iron. If a furnace were driven too fast, when a certain point was reached the slag changed suddenly, and he knew then that the furnace bed had not had time to smelt the iron properly. There were limits which the speed of the furnace must not exceed. Speaking of Cleveland foundry pig-iron, he observed no difference in the pig-iron produced to-day, because the Cleveland furnaces had always been driven up to their limit, and the only difference in the furnace was that probably the hearth was now bigger. The temperature of the hearth was not increased, nor the rate of driving. Cleveland pig-iron to-day was exactly the same commodity that it was 30 years ago.

Mr. West said he was inquiring for Major Scott's general opinion on the use of high temperature and pressure blast, and not particularly the practice carried out at the Cleveland works. He fully agreed that the foundryman and the blast-furnaceman should co-operate, but in fairness to the foundryman it ought to be said that it was not sufficiently appreciated by the makers of pig-iron how important a matter it was to supply their material within the specifications required by the foundryman without the latter having to check the composition before using it. It had been noted repeatedly that the foundry with a laboratory received more consistent supplies than those without such means of checking purchases, and it was on behalf of the small foundryman he made this criticism.

### Compositional Variations.

Major Scott said if the furnace was too hot they did not get the brand of pig-iron they were aiming at. The only thing they could control was the silicon, and in a No. 3 Cleveland foundry iron they aimed to get 2.5 to 3.5 per cent. silicon. If the furnace was too hot the silicon might be anything up to 5 per cent., and he did not call that a saleable iron. He insisted that the same grade of iron was being made now as formerly.

Mr. R. A. Miles said he understood Major Scott to say that the silicon content was from 2.5 to 3.5 per cent. That variation was too great. In grading pig-iron the difference in silicon should not be more than 0.5 per cent. If there were going to be the variation Major Scott mentioned, it should be made known on every wagon-load that was sent to customers.

Major Scott: I agree.

Mr. Miles added that with each wagon there should be sent an analysis of the very variable constituents in each wagon from the pig-bed. This would regulate foundry practice to a much better degree than had been done hitherto; then there would not be as much variation from specification in pig-iron. Many users did not rely upon analysis, but rather upon blast-furnace attendants' selection. If the time had come for foundrymen to insist upon having full analyses, or of those variable constituents such as carbon and silicon, it was up to them to demand it, and he was certain that metallurgical control in foundries was sufficiently established to create this demand.

Major Scott agreed to some extent. As far as carbon, phosphorus and manganese were concerned, the grade of iron was always the same; the silicon varied. There were three classes of foundry customers. One wanted iron entirely by analysis, another wanted it entirely by fracture; then there was the third who wanted both fracture and analysis. In the speaker's own practice, any customer who asked for an analysis of pig-iron could have, on every wagon that was sent out, the analysis of silicon and sulphur. Up to now the iron had been sold on fracture only, and that was still the commercial practice, but they had endeavoured to alter it, and if a customer asked for a particular silicon in the iron they endeavoured to give it to him. They had done that scores of times. Every day practically they sent out analyses of pig-iron, as far as the silicon and sulphur were concerned.

### Progress Achieved.

Mr. H. Sherburn said Major Scott seemed to be the representative of a new school of thought among the makers of pig-iron, owing to his desire to obtain the point of view of the users of pig-iron and particularly of foundrymen. In the past pig-iron makers appeared to have concealed themselves behind the merchants, and there had not been any real attempt to find out the wishes of individual users. He remembered many discussions under the auspices of the Branch when the question of fracture was debated, and he thought in every case it was proved that the stumbling block against the grading of pig-iron upon a more reliable basis was the attitude of the makers, and not the fault of the purchasers, as had been suggested.

With regard to the question of machine-cast pig-iron, he thought it was the function of the pig-iron makers, as the suppliers of the commodity, to place before the users the merits of the machine-cast pig-iron and the objections to the older method of sand-cast pig-iron. If his memory served him aright, there again the pig-iron makers had been the chief stumbling block against the development of machine-cast pig-iron, apparently because the present scheme enabled sand to be sold at pig-iron prices. One need only go back in the history of the Branch 15 years or more to recall that the subject had been thrashed out repeatedly, and in every case the responsibility for the *status quo* had to be put on the pig-iron makers. It was pleasing, therefore, to have with them Major Scott, who apparently had the new point of view, and to feel that they could hope in the near future to receive better service from the people upon whom they depended so largely for their supplies.

With regard to the suggestion to give analyses with every wagon of pig-iron, before that could be really effective the people who used the materials, and ought to understand more or less about them, must be heard. In many cases the people who actually used pig-iron in the foundry had little or no say in its purchase. That fact must be borne in mind. In some organisations with many departments, the purchasing was done by men whose qualifications did not include an intimate knowledge of pig-iron. He would like Major Scott to tell them what was the current practice in regard to the use of scrap in the blast-furnace charges from which ordinary brands of pig-iron were made. Cases where that was done were within his knowledge, and he wondered whether it was being developed and what was the effect upon the product.

The pig-iron situation had changed considerably from what it was a few years ago. Under the zone arrangement pig-iron makers divided the country into an arbitrary number of groups and had decided that certain brands of pig-iron should be sold at certain prices within those

groups. If it were impossible for an individual user to overcome that arrangement, he was naturally going to try to get the best value for his money amongst the various brands of pig-iron that were available. He would choose those brands which showed the best physical and chemical qualities, and the poorer brands would ultimately suffer in demand. Many years ago Cleveland iron came into the Manchester district very largely, but to-day it was practically out of that market, simply on account of price. Cleveland iron now created little or no interest in that area. The question was whether the price arrangements and the group arrangements were going to persist. If they did, the foundrymen must take due note of his situation and be prepared to meet it.

### Scrap Additions to Blast-Furnace Burdens.

Major Scott said the blast furnace had a deoxidising effect, whereas the cupola had an oxidising effect. He believed that if the material put into the blast furnace contained ferrous-oxide, that ferrous-oxide would be removed by the reducing action of the furnace, if the furnace were working normally. No scrap, except that from the pig-bed or current scrap, was put into a blast furnace making Cleveland foundry pig-iron. In furnaces making basic iron for steelworks, it did not matter how much scrap was put into the furnace.

### Wall Erosion.

Mr. E. Longden said he had been looking forward to some further reference to actual comparisons between the blast furnace and the cupola. Many interesting questions had been brought to light. Major Scott referred to the probability of there being reasons other than temperature for the failure or cavitation of the furnace lining. In his opinion, that was quite correct. In the cupola it was evident that in addition to temperature there was erosion, due to the friction of the charge combined with the pressure of the burden, and, also, there was chemical action, particularly of the slag, apart from the furnace gases. In the ordinary type of cupola they were accustomed to admitting air to the cupola through a number of tuyeres arranged in one or two rows, the idea being to blow air into the cupola and so to narrow down the combustion zone and burn the fuel vigorously in that zone. The almost continuous one row of tuyeres had not met with success. With a single and almost continuous row of tuyeres the air held up the slag falling down the lining, just above the tuyeres, holding the slag on to the lining; and there chemical action took place, with consequent heavy corrosion of the lining. This took place when the cupola was run at quite a low temperature. The cupola could be run at a much higher temperature in cupolas with multiple tuyeres distributed at various points, as in the Poumay cupola. With a large number of tuyeres distributing the blast, corrosion of the lining was comparatively small, and there was conclusive proof that temperature played quite a small part with a correct type of brick.

With regard to sand on the pig, foundrymen naturally always expected a corresponding reduction. It was a question of price. If the blast-furnace people supplied an iron without adhering sand, they would be paid for it just the same. It might sound almost absurd, but there was a certain advantage in having sand on the pig. It certainly saved the lining. In melting white iron in the cupola for malleable iron, a heavy fluxing of the lining occurred, and the practice was in certain cases actually to charge sand into the cupola. An interesting point arose with regard to the temperature. Was it possible to get an explanation of the temperature effect upon the lining by comparing a hot-blast furnace with a cold-blast furnace? In the former, one expected a greater loss of lining, but he did not think that was experienced.

### The Newer Products.

Major Scott had asked what foundrymen required. They were continuously asking for dependable analyses. Some foundrymen asked for, and obtained, what they wanted; if they did not they sent the iron back. Melting iron was not as exact a process as melting steel; it was much more difficult. There were furnaces on the market which helped them to melt metal nearer to what they would like it to be, but they were a long way off completely controlling it. Probably Major Scott had heard of Emmel, Lanz and Meehanite iron. Metallurgists had certainly helped them considerably in recent years in regard to cast-iron alloys, and from the engineer's point of view they had much improved the qualities of cast iron. To-day iron was produced with a tensile strength of 40 tons per sq. in., but it was at considerable expense. Within the last week he had seen produced a nickel alloy which gave 22 tons tensile per sq. in. It had nothing to do with the hot-mould process but was simply a straight cupola-melted metal, with a low silicon and a certain addition of nickel, giving a perfectly pearlitic structure.

### Alkalis in Furnace Gases.

Major Scott said with regard to the lining he suggested that the alkaline salts in the ascending gases of the blast furnace tended to decompose the brickwork by a slagging effect. He did not think temperature had anything to do with the wasting of the lining. His theory was that gases containing alkaline salts penetrated the joints of the brickwork forming the lining of the furnace, and, combining with the silica of the brick, produced a slagging effect which gradually ate away the lining of the furnace. The best covering for the lining of a furnace was a carbon covering. Once that could be obtained the life of the lining might be prolonged indefinitely.

### Judging by Fracture.

Mr. S. G. Smith said he had been associated with Cleveland iron for 25 years, and could appreciate much that Major Scott had said. Major Scott had stated, when referring to fracture, that he could judge the iron better in the molten state when the furnace was being tapped. He had stood at Major Scott's side—although Major Scott did not know it—and watched the stream of molten metal coming down the sow and running into the pigs. When foundrymen ventured in blast-furnace plants, as they sometimes did, they felt it was holy ground. On the occasion he had in mind, when the furnace was being tapped Major Scott was watching the stream of molten metal, and he would remark that it was a No. 4 iron, then a forge and so on; which indicated that Major Scott did know to some extent in the liquid state what the metal was and what the general composition was likely to be. He assumed that Major Scott still judged and graded by fracture in the pig-bed, and that fracture and grade number had a relation to composition; at least that was what he (Mr. Smith) had always understood. Although fracture appearance was deceiving, if one knew the type of furnace, the nature of the ore or ironstone the furnace was using, and also the general conditions of the plant, the appearance of the fracture under normal working was indicative of and did bear, or ought to bear, some relation to composition.

Major Scott said the fracture was a general indication of the iron. Everything else being known, the speed at which the iron ran into the bed, and the time it took to cool on the bed, one could expect to get from the fracture of that pig a certain analysis. In Cleveland pig-iron, the foreman who lifted the iron not only saw the fracture, but also knew the analysis of it. According to both he stocked his iron.

### By-Products.

The Chairman said the suggestion that an analysis be sent to the customer with each truck of pig-iron was one of the best suggestions he had heard for a long time. He understood that it was already done in Middlesbrough.

Major Scott: We only do it when we are asked.

The Chairman said the last lecture on blast-furnace practice given before the Branch was about three years ago. On that occasion the lecturer emphasised the importance of the by-products obtained, the impression created in the mind was that all the profit was obtained out of the by-products and that the pig-iron itself was the real by-product.

Major Scott replied that the only by-products of the blast furnace were the slag and the gas. Cleveland slag was one of the finest slags for road-making. To use the gas for calcining ironstone had been found extravagant. Furnace gas was being increasingly used for reheating furnaces in steelworks and for many other purposes. It was an exceedingly valuable by-product.

## Metallurgists' Conferences in Switzerland.

Switzerland will be the scene of this year's autumn meeting of the Institute of Metals. It is being held in Zürich, from September 13 to 18, by kind invitation of the Schweizerische verband für Materialprüfung. The evening of September 13 will be devoted to the formal opening of the meeting, addresses of welcome by the inviting body and the Autumn Lecture, which is to be given Mr. U. R. Evans, M.A., on "Thin Films on Metals in Relation to Corrosion Problems." An entertainment will afterwards be given in the Great Hall of the Zürich Polytechnic.

The mornings of September 14 and 15 will be devoted to the reading and discussion of Papers, whilst for the afternoons visits have been provisionally arranged to the works of Escher, Wyss & Company, Zürich; Maschinenfabrik Oerlikon, Oerlikon; Brown, Boveri & Company, Baden; Sulzer Brothers, Winterthur; Kraftwerke Wäggital, Wäggital; Eisen & Stahlwerke, vorm. G. Fischer, Schaffhausen; and Alfred J. Amsler & Company, Schaffhausen. A Ladies' Committee is arranging visits by the ladies of the party to the Kunsthaus, Uetliberg, Landesmuseum, and the Wäggital.

In the evening of September 14, members and their ladies will be the guests of the City and Canton of Zürich at one of the hotels on the heights above the city, whilst for the next evening an excursion by steamer on Lake Zürich, followed by a dinner and dance at a lake-side village, is being arranged. On September 16, an excursion will take place to the Rigi, the party going thence by steamer to Lucerne, where the night will be spent.

On September 18, the main party will divide, one going to Biel to visit a watch factory and leaving England in the evening, whilst the other will go via Lötschberg to visit the new aluminium-alloys rolling mills at Chippis-Siders in the Rhône Valley. From Chippis members will either return to London via Lausanne or Geneva, or proceed via the Simplon to Milan to take part in the International Foundry Exhibition and Congress, which continues at Milan until September 27.

During the week preceding the Institute of Metals meeting there will be held, also in Zürich, the first congress of the New International Association for Testing Materials; thus, inclusive of the Milan Congress, there will be taking place in Switzerland and Italy during September a series of meetings covering three weeks. In view of the fortunate juxtaposition of these important international gatherings, it is expected that they will be largely attended by metallurgists and engineers from all parts of the world.

Further particulars may be obtained on application to Mr. G. Shaw Scott, M.Sc., 36-38 Victoria Street, London, S.W.1.

## Trade Talk.

The American National Association of Cost Accountants will hold its twelfth international cost conference at the William Penn Hotel, Pittsburgh, Pa., from June 15 to 18.

The Ailsa Shipbuilding Company, Limited, Troon, have contracted to build a steel single-screw steamer of 1,100 tons deadweight for Messrs. J. Hay & Sons, Limited, Glasgow.

It is expected that the works of the Darlington Rustless Steel & Iron Company, Limited, will reach production stage some time next month. The firm is the sole licensee in Great Britain of a new process for the manufacture of stainless metals.

Messrs. Crossley Bros., Limited, Manchester, have received from the British Broadcasting Corporation an order for four 350-b.h.p. vertical oil engines, which are to be installed in the new Scottish Regional Station at Falkirk, the latest of its type.

The negotiations in Berlin between a Soviet delegation and the German Federation of Industry in respect of the delivery of 300,000,000 mks. (£15,000,000) worth of orders for machinery and other products have been successfully concluded.

The crucible-steel business of Messrs. Camm, Bagshaw & Company, Queen's Road Steelworks, Sheffield, has been purchased by Mr. H. A. Potts, managing director of the late company of Jno. Hy. Andrew & Company, Limited, Toledo Steel Works, Sheffield. The business is to be converted into a limited liability company.

The Wellman Smith Owen Engineering Corporation, Limited, have recently received a repeat order from the Continent for eight Wellman-type L.10½ mechanical gas producers. During the past twelve months the company have supplied 30 producers to Continental users for service in steel, glass and zinc-smelting works.

Messrs. Dorman, Long & Company, Limited, have received the contract for the supply and erection of the structural steelwork for the new Victoria Coach Station, Buckingham Palace Road, which is being built for London Coastal Coaches, Limited. Approximately 1,200 tons of steel will be employed, and will be erected in eight weeks.

The Shipbuilding Employers' Federation have invited the shipyard trade unions to a conference to discuss the serious position in which the shipbuilding and ship-repairing industry finds itself at the present time. All the unions invited have agreed to attend, and it has been arranged that the conference will take place in London on April 24.

Messrs. Gjers, Mills & Company, Limited, have decided to restart the Ayresome Ironworks, Middlesbrough, early next month, when two blast furnaces will be put into operation. The works have been closed for eight months owing to the depression in the pig-iron industry, but stocks have been disposed of and orders have come forward to justify a resumption of activities.

A step towards securing greater national uniformity in building practice was taken recently, when a conference was convened by the Briitsh Engineering Standards Association to discuss the adoption of standard specifications for building components. Mr. Arthur Greenwood, the Minister of Health, addressed the conference, at which the steel trade was represented.

The Fried. Krupp Grusonwerks, of Magdeburg, and the Andreas Machinery Manufacturing Company, of Muenster, have come to an arrangement as regards cement-factory plant. The Krupp Grusonworks are to take over the whole of the cement-machinery department of the Andreas Company, and Mr. Andreas has undertaken to act as a technical adviser to the Krupp Grusonworks.

The balance-sheet of the Aciéries Réunies de Burbach-Eich-Dudelange (Arbed), in Luxemburg, for the year ended with December 31, 1930, shows net profits available for distribution amounting to 60,758,514 fcs., of which 3,037,926 fcs. are to be placed to the reserve fund, the interim dividend absorbed 6,250,000 fcs., directors' fees, etc., 7,720,588 fcs., and the final dividend 43,750,000 fcs.

A new policy has been inaugurated by Messrs. William Beardmore & Company, Limited, Glasgow, in connection with Diesel engine manufacture. It has so far been the custom to make these engines to order only, but in future the company intends to stock some of the more popular sizes. By this means delivery will be considerably expedited and costs reduced. The Diesel engines manufactured by the company range from 24 h.p. to 14,000 h.p.

Messrs. Hollings & Guest, Limited, engineers, Thimble Mill Lane, Birmingham, have in hand some large orders for machinery, including two horizontal sludge pumps for the Birmingham Tame and Rea District Drainage Board and two pumps for the Coventry Corporation. The firm supplied recently a big crane for the Great Western Railway Company at Smithfield Market, London, and have a large press and accumulator on order for the Admiralty.

The General Electric Company, Limited, has been awarded the contract for the complete equipment of four new traction sub-stations for the London Electric Railway Company, at Sudbury Hill, Alperton, North Ealing and Northfields. The equipment comprises a total of ten 1,500 kw. remote-controlled mercury-arc rectifiers, together with the whole of the automatic control gear, air-blast transformers, high-speed circuit-breakers, cabling, lighting, etc. This is one of the largest orders for mercury-arc rectifiers placed in this country.

Messrs. John A. Smeeton, Limited, of 15, Victoria Street, Westminster, London, S.W.1, have entered into an agreement with Messrs. Robson Refractories, Limited, of Darlington, to act as their sole representatives for Birmingham and district and the South of England for the sale of "Cupoline," "Fluxitol" and "Finitol." They have also taken over the control and management of the Mineral & Refractory Products, Limited, late of 24, Minories, London, E.C.3, which company possesses the sole selling rights for Great Britain for the high-class silica refractory concrete and cement known as "Pyresit B1 and B3," and the sole selling rights for export to all the British Dominions and dependencies for "Cupoline," "Pyresit," "Fluxitol" and "Finitol."

The Newcastle-upon-Tyne Electric Supply Company have placed further contracts, to the value of £160,500, in connection with the standardisation of frequency. These contracts include orders to Sir Robert McAlpine & Sons, of Newcastle, representing £58,500, for foundations and other work at the new Dunston power station site. Other contracts, in respect of the balance amounting to £102,000, which includes £20,000 to be expended on local labour at site, are for four 50-cycle turbo-alternators to be supplied by the Metropolitan-Vickers Electrical Company, Limited, of Manchester. Two of these machines will replace existing Metropolitan-Vickers 40-cycle turbo-alternators, each of 20,000 kilowatts capacity, at the North Tees "A" power station, and the other two, each having a capacity of 2,000 kilowatts, will be installed at Ashington power station in the place of existing 40-cycle sets.

## Reports and Dividends.

**Monk Bridge Iron & Steel Company, Limited.**—Profit, £1,528, reducing the debit balance brought in to £139,431.

**British Electric Transformer Company, Limited.**—Debit balance of £32,534, which amount has been transferred from reserve.

**Allen-Liversidge, Limited.**—Final dividend on the ordinary shares for the eight months ended December 31 of 2½ per cent. (actual), equivalent to a rate of 8 per cent. per annum.

**Yorkshire Engine Company, Limited.**—The directors state that while the results for 1930 show a profit of £1,561, compared with a loss of £2,201 in 1929, the present position is difficult. They recommend that no dividend be declared on either the 5 per cent. cumulative preference or ordinary shares.

## Contracts Open.

**Cairo,** May 16.—765 metres of cast-iron or steel socket pipes, for the Egyptian Ministry of the Interior. The Department of Overseas Trade. (Reference G.X. 10,309.)

**Cape Town,** June 15.—Pumping equipment, for the City of Cape Town. The Department of Overseas Trade. (Reference G.X. 10,302.)

**Salford.** — 20-ton weighbridge. The Superintendent, Lighting and Cleansing Department, Wilburn Street, Salford.

**Wellington, N.Z.,** May 27.—150 tons of rails, with fishplates and bolts, for the Dunedin Corporation Tramways. The Department of Overseas Trade. (Reference G.X. 10,308.)

## Personal.

Mr. G. H. A. Sington has been elected a director of Messrs. Platt Bros. & Company, Limited, Oldham.

Mr. Robert Fothergill, of the Caledon Shipbuilding & Engineering Company, Limited, Dundee, has been appointed organiser for the National Council of Industry and Commerce in the North-East district, with headquarters at Newcastle. A native of Tyneside, Mr. Fothergill began his shipbuilding connection with Messrs. R. & W. Hawthorn, Leslie & Company, Limited, Hebburn-on-Tyne. He had been associated with the Caledon Company since 1919, becoming secretary in 1923. He takes up his new appointment at the beginning of May.

### Wills.

Binks, R. A., a director of Binks Bros., Limited, wire-rope manufacturers, of Millwall, London, E.14 ... ... £6,649

Rhodes, W., formerly managing director of Harding, Rhodes & Company, Limited, steel-pin manufacturers, of Tower Works, Leeds ... ... ... £110,121

Livesey, R. C., managing director of Henry Livesey, Limited, loom makers, of Greenbank Foundry, Blackburn, the chairman of Hutchinson, Hollingworth & Company, Limited, textile engineers and ironfounders, of Dobcross ... ... ... ... ... £43,774

## Obituary.

Mr. W. A. Grainger, commercial manager of the Scunthorpe branch of Messrs. John Brown & Company, Limited, died recently.

Mr. Alexander Rhind, for many years manager of the Wallsend Brass Works of Messrs. M. W. Swinburne & Sons, Limited, Wallsend-on-Tyne, died recently. He retired about three years ago.

Mr. John Hedley Nicholson, resident engineer for Messrs. Dorman, Long & Company, Limited, at the new Tees-Newport bridge, died on April 9 following a motor accident. He was 47 years of age and had been on the staff of Messrs. Sir William Arrol & Company, Limited.

Mr. Frank Barnard Saunders, for many years secretary and commercial manager of the Rhymney Iron Company, Limited, died suddenly, aged 64. Mr. Saunders entered the service of the Rhymney Iron Company in 1888, and was appointed secretary and commercial manager in 1911. He retired in 1920.

## New Companies.

**Lead, Brass & Iron Works, Limited.**—Capital £20,000. Solicitors: Wragge & Company, Birmingham.

**John Hyams & Sons, Limited,** 11, Glengall Terrace, Trafalgar Road, London, S.E.—Capital £3,000. Scrap metal merchants, etc.

**Putney Bridge Iron Works, Limited,** 3a, High Street, Putney, London, S.W.—Capital £3,000. Directors: C. W. A. and Mrs. N. Teuton.

**John Lund, Limited,** Eastburn Foundry, Crosshills, West Riding, Yorks.—Capital £15,000. Machine-tool makers, etc. Directors: A. D. and J. Lund.

**W. H. Robinson, Limited,** George Street, Milnsbridge, near Huddersfield.—Capital £6,000. Metal and machinery merchants, etc. Directors: W. H., Mrs. L. E., A. E. and A. Robinson.

Research on behalf of the Government with a view to discovering the possibilities and need for new industries in the North-East of England is to be undertaken by Professor H. M. Hallsworth, head of the Department of Economics at Armstrong College, Newcastle, and two assistants. The survey is expected to be completed at the end of the year, when the conclusions will be forwarded to the Government.

# Iron and Steel Markets.

## Pig-Iron.

**MIDDLESBROUGH.**—The market has not yet recovered its normal position. The long-continued absence of tonnage at the shipyards has caused such a depression among the consuming trades of this area, from whom the majority of orders for pig-iron emanate, that the recovery is slow and uncertain. The export trade, also, is overcast by the prevailing depression, and there is a wide disparity between British and foreign prices. Even in Scotland, Cleveland ironmasters find it impossible to compete on equal terms with the Continental producers, who are offering pig-iron f.o.t. Grangemouth at about 6s. to 8s. per ton below the special rate which the Cleveland ironmasters are quoting in that area. On the whole, equilibrium seems to have been attained between production and consumption, since stocks of iron are practically unchanged since the beginning of the year. However, less than 25 per cent. of the blast furnaces on the North-East Coast are now in operation, and it is many years since production was on so small a scale. The Cleveland ironmasters have recently benefited by a reduction in the blast-furnacemen's and ironstone miners' wage rates. Under the sliding scales the former have been reduced by 2¼ per cent., and the latter by 4¼ per cent., but the total saving per ton of pig-iron will be relatively small, and, as fuel costs show a tendency to advance, there is little likelihood of pig-iron prices being reduced to the consumer. The actual ascertained net selling price of No. 3 Cleveland G.M.B. pig-iron for the first quarter of the year, on which the new wage rates have been based, is certified as 56s. 3.37d. per ton, but the actual quoted price for all areas except Scotland remains unchanged at 58s. 6d. No. 1 foundry is quoted at 61s., No. 4 foundry 57s. 6d. and No. 4 forge pig-iron 57s. per ton.

The outlook in hematite remains very uncertain. However, the fact that Messrs. Gjers, Mills & Company have decided to restart two hematite furnaces at their Ayresome ironworks next month may be taken as an indication that producers entertain a hopeful view of the outlook. It is understood, in fact, that this firm have disposed of practically the whole of their stock of iron, and have booked orders for British firms, which will ensure continuity of operations for possibly three months ahead. It is true that prices are still on the down grade, but it is suggested that a tendency for raw materials to advance may arrest the steady decline in values. Ideas as to current prices show a good deal of variation, and one firm refuses to sell at less than 70s. per ton. On the other hand, the recognised market quotation for East Coast mixed numbers is now no more than 66s. 6d. per ton, and export sales have been negotiated at much less. The quotation for Bessemer mixed numbers in the North-West of England remains unchanged at 68s.

**LANCASHIRE.**—The continued cheap offers of scrap iron are having an undoubted effect on the consumption of pig. A good deal of the scrap available is said to be of very good quality, much of it having been originally textile machinery of various kinds, and supplies are being freely offered at a top price of about 40s. a ton delivered to buyers' works. How long it will be before the abnormal supplies are absorbed remains to be seen, but from the point of view of the pig-iron producer it cannot be too soon. Transactions in foundry iron this week have been very small, and up to the present makers' hopes of the usual slight beginning-of-the-month buying spurt have been disappointed. For delivery to consumers in the Manchester price zone, Derbyshire and Staffordshire descriptions continue to be quoted at 69s. 6d. per ton, with North-East Coast iron at 69s. 6d., Northamptonshire foundry at 68s., Derbyshire forge at 64s. 6d., Scottish foundry brands at from 83s. to 90s., and West Coast hematite iron at around 82s. 6d.

**MIDLANDS.**—There had been hopes of an improvement in present conditions, but so far little demand has materialised for pig-iron in this area. Transactions are mainly for limited tonnages for immediate requirements. The figures quoted by the furnaces for delivery to Birmingham and Black Country stations are 67s. 6d. for Northants No. 3 and 71s. for Derbyshire, North Staffordshire and Lincolnshire No. 3.

**SCOTLAND.**—Owing to their inability to keep their works in operation, consumers are asking for suspension of deliveries against purchases made. There seems to be even less business circulating than hitherto. The price of Scottish foundry iron is 73s. 6d. per ton, f.o.t. furnaces, with a minimum of 2s. 6d. per ton extra for No. 1. Continental No. 3 is at 52s. 6d. f.o.t. Grangemouth, with Middlesbrough No. 3 at 60s.

## Finished Iron.

No improvement can be reported in this market, conditions being irregular and working intermittent. Most of the mills are operating two or three days weekly. The price of South Staffordshire marked bars is unchanged at £12 10s. at works, with crown bars at from £9 5s. to £10. The mills making this latter grade of iron are worse situated than the makers of marked bars. They are quite unable to get sufficient business from consumers and stockholders to warrant anything like regular rolling operations. Nut and bolt iron is similarly situated, but the cause of the paucity of business for this grade is mostly the foreign competition. Nut and bolt iron from Belgian and French works is still being offered here at very low rates, the current level being between £4 15s. and £4 17s. 6d. delivered consumers' works in the Black Country area.

## Steel.

The shipbuilding depression has had a grave effect on the finished-steel trade, which is not compensated for by expanding sales in other directions. No more railway orders have been given, and other steel-consuming industries have comparatively light requirements. With the demand for finished steel so restricted, little business is in evidence for semi-finished steel. In spite of the paucity of business, Continental prices are rising and have a firm tendency. Some of the Continental mills are out of the market. For ordinary specifications of sheet bars £3 11s. f.o.b. Antwerp is now being quoted. Prices of British semis are unchanged. All the galvanised-sheet works are short of orders.

## Scrap.

Merchants in the Cleveland area complain that the iron and steel scrap market has rarely been so depressed. There are no buyers, and prices are nominal. Ordinary-quality cast-iron scrap is at 47s. 6d., with good machinery quality at 49s. The market in the Midlands is quiet also. Dealers have great difficulty in booking orders for any substantial amount. The price of good heavy machinery cast-iron scrap in cupola sizes is 55s. to 57s. 6d., and light cast iron is at 37s. 6d. Business in the Scottish market is almost at a standstill, as the works, with few exceptions, have suspended deliveries. Prices are largely nominal. First-class machinery metal, in pieces not exceeding 1 cwt., is quoted at 50s. to 52s., while ordinary cast-iron scrap to the same specification is at 47s. 6d. The above prices are all delivered consumers' works.

## Metals.

**Copper.**—The slight interest shown in this market after the issue of the American copper statistics has subsided, as, after two or three days of moderately good buying, the needs of Europe seemed to be satisfied. Therefore, despite the sharp reduction in the American stocks, it is difficult to feel very confident as to the general position of copper. The decrease in the quantity of refined metal on hand was largely a result of heavy domestic deliveries, which are hardly likely to be maintained in the present month. Indeed, many consumers have been rather sceptical about the increase, although there can be little doubt that the actual demand was higher in March than in the two preceding months.

Closing quotations :—

*Cash.*—Thursday, £42 16s. 3d. to £42 17s. 6d.; Friday, £42 13s. 9d. to £42 16s. 3d.; Monday, £42 10s. to £42 12s. 6d.; Tuesday, £42 11s. 3d. to £42 12s. 6d.; Wednesday, £42 11s. 3d. to £42 12s. 6d.

*Three Months.*—Thursday, £43 8s. 9d. to £43 10s.; Friday, £43 7s. 6d. to £43 8s. 9d.; Monday, £43 3s. 9d. to £43 6s. 3d.; Tuesday, £43 5s. to £43 7s. 6d.; Wednesday, £43 5s. to £43 6s. 3d.

**Tin.**—The demand from consumers has been quiet, although a spasmodic interest has been shown by America and the Continent. The market has been influenced by "bear" tactics, and by the continued selling of smaller speculators who have been effected by the low prices. Another factor to be considered is the feeling of uncertainty regarding the ability of the international output restriction scheme to overcome the opposition with which it is meeting.

Official closing prices :—

*Cash.*—Thursday, £111 15s. to £111 17s. 6d.; Friday, £111 17s. 6d. to £112; Monday, £112 2s. 6d. to £112 5s.; Tuesday, £110 17s. 6d. to £111; Wednesday, £111 to £111 2s. 6d.

*Three Months.* — Thursday, £113 2s. 6d. to £113 5s.; Friday, £113 7s. 6d. to £113 10s.; Monday, £113 10s. to £113 12s. 6d.; Tuesday, £112 5s. to £112 7s. 6d.; Wednesday, £112 7s. 6d. to £112 10s.

**Spelter.**—The spelter market is very weak. The galvanising industry generally is in such a bad state that arrivals, especially from Canada and Australia, are more than sufficient for requirements, and, although there is no doubt a reduction in output on the Continent, stocks in Europe have increased substantially during the past six months.

Daily fluctuations :—

*Ordinary.*—Thursday, £11 7s. 6d.; Friday, £11 7s. 6d.; Monday, £11 5s.; Tuesday, £11 3s. 9d.; Wednesday, £11 5s.

**Lead.**—The market is quiet, and, since the news that a cut in production had definitely been decided upon, it has been rather uneventful. Values have had an easier tendency.

The week's prices have been :—

*Soft Foreign (Prompt).*—Thursday, £12 12s. 6d.; Friday, £12 11s. 3d.; Monday, £12 13s. 9d.; Tuesday, £12 10s.; Wednesday, £12 5s.

CAST IRON FLANGED PIPES
2 in.–12 in. & CONNECTIONS. to 24 in. dia.
WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.
JAMES & RONALD RITCHIE, LTD.,
Telephone : 3852 (2 Lines). MIDDLESBROUGH. Telegrams : "Ritchie, Middlesbrough."

Special CARBON BLACKING

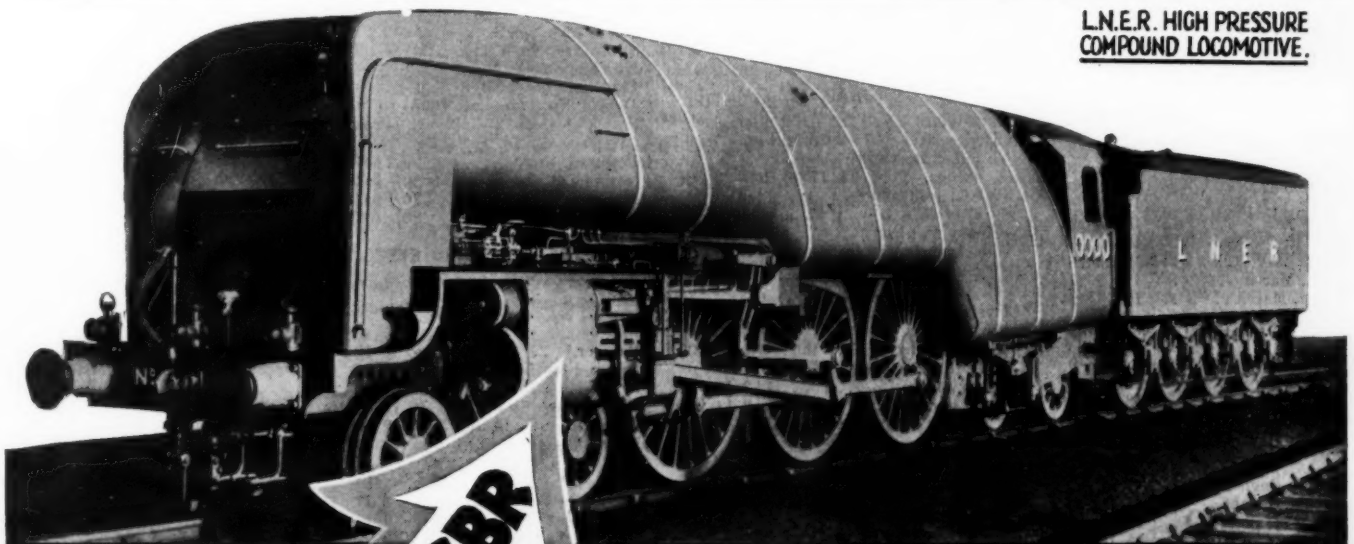
PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST
REQUISITES

67 MADE BY A FIRM WITH YEARS EXPERIENCE.

JAS. DURRANS & SONS LIMITED.
PHŒNIX WORKS, PENISTONE, NR SHEFFIELD.

Also—
GANISTER,
LOAM AND SAND MILLS.
STUDS,
CHAPLETS,
BRUSHES,
CORE ROPES,
BUCKETS,
SPADES, Etc.
LADLES,
FIRE BRICKS,
STONE FLUX,
CASTING CLEANERS,
PIPE NAILS,
SPRIGS,
WIRE BRUSHES,
BELLOWS.

L.N.E.R. HIGH PRESSURE COMPOUND LOCOMOTIVE.




WARNER CBR

WARNER CBR
CYLINDER PIG IRON.
SPECIFIED BY THE L.N.E.R. FOR THE CAST IRON LOW PRESSURE CYLINDERS OF THE ABOVE LOCOMOTIVE. THEIR COMPLETE CONFIDENCE IS THE RESULT OF LONG EXPERIENCE WITH WARNER CBR IN ALL THEIR LOCOMOTIVE CYLINDERS.

WARNER & CO. LTD., CARGO FLEET, MIDDLESBROUGH ON TEES.
TELEPHONE — MIDDLESBROUGH 4265 TELEGRAMS — "REFINERY, MIDDLESBROUGH"

# WEEKLY PRICE CURRENT.

## COPPER.

| | £ s. d. |
|---|---|
| Standard cash | 42 11 3 |
| Three months | 43 5 0 |
| Electrolytic | 46 0 0 |
| Tough | 43 0 0 |
| Best selected | 43 10 0 |
| Sheets | 75 0 0 |
| India | 56 0 0 |
| Wire bars | 46 8 9 |
| Do., May | 46 8 9 |
| Do., June | 46 8 9 |
| Ingot bars | 46 8 9 |
| H.C. wire rods | 48 10 0 |
| Off. av. cash, March | 44 17 2¼ |
| Do., 3 mths., March | 45 7 6 1/32 |
| Do., Sttlmnt., March | 44 17 4 7/32 |
| Do., Electro, March | 48 3 4 19/32 |
| Do., B.S., March | 46 9 8 3/32 |
| Do., wire bars, March | 48 12 10 1/32 |
| Solid drawn tubes | 11d. |
| Brazed tubes | 11d. |
| Wire | 7d. |

## BRASS.

| | |
|---|---|
| Solid drawn tubes | 9½d. |
| Brazed tubes | 11½d. |
| Rods, drawn | 9½d. |
| Rods, extd. or rlld. | 5½d. |
| Sheets to 10 w.g. | 8½d. |
| Wire | 8½d. |
| Rolled metal | 7½d. |
| Yellow metal rods | 5½d. |
| Do. 4 × 4 Squares | 6d. |
| Do. 4 × 3 Sheets | 6½d. |

## TIN.

| | £ s. d. |
|---|---|
| Standard cash | 111 0 0 |
| Three months | 112 7 6 |
| English | 112 0 0 |
| Bars | 114 0 0 |
| Straits | 113 0 0 |
| Australian | 112 2 6 |
| Eastern | 114 2 6 |
| Banca | 113 17 6 |
| Off. av. cash, March | 121 18 4 1/32 |
| Do., 3 mths., March | 123 8 4 9/32 |
| Do., Sttlmt., March | 121 18 2 7/32 |

## SPELTER.

| | £ s. d. |
|---|---|
| Ordinary | 11 5 0 |
| Remelted | 10 2 6 |
| Hard | 8 17 6 |
| Electro 99.9 | 13 10 0 |
| English | 11 12 6 |
| India | 10 5 0 |
| Zinc dust | 19 0 0 |
| Zinc ashes | 2 15 0 |
| Off. aver., March | 12 8 7 23/64 |
| Aver. spot, March | 12 3 9 15/64 |

## LEAD.

| | £ s. d. |
|---|---|
| Soft foreign ppt. | 12 5 0 |
| English | 13 15 0 |
| Off. average, March | 13 4 9 1/4 |
| Average spot, March | 13 2 6 1/4 |

## ZINC SHEETS, &c.

| | £ s. d. |
|---|---|
| Zinc sheets, English | 20 0 0 |
| Do., V.M. ex-whf. | 19 10 0 |
| Rods | 22 15 0 |
| Boiler plates | 13 10 0 |
| Battery plates | 15 0 0 |

## ANTIMONY.

| | £ s. d. |
|---|---|
| Special brand, Eng. | 36 0 0 |
| Chinese | 24 15 0 |
| Crude | 22 0 0 |

## QUICKSILVER.

| | £ s. d. |
|---|---|
| Quicksilver | 22 7 6 |

## FERRO-ALLOYS AND STEEL-MAKING METALS.

| | |
|---|---|
| Ferro-silicon— | |
| 25% | 7 10 0 |
| 45/50% | 10 10 0 |
| 75% | 16 17 6 |
| Ferro-vanadium— | |
| 35/50% | 12/8 lb. Va. |
| Ferro-molybdenum— | |
| 70/75% c. free | 4/2 lb. Mo. |
| Ferro-titanium— | |
| 23/25% carbon-free | 9d. lb. |
| Ferro-phosphorus, 20/25% | £15 15 0 |
| Ferro-tungsten— | |
| 80/85% | 1/8½ lb. |
| Tungsten metal powder— | |
| 98/99% | 1/11½ lb. |
| Ferro-chrome— | |
| 2/4% car. | £29 0 0 |
| 4/6% car. | £21 0 0 |
| 6/8% car. | £19 15 0 |
| 8/10% car. | £19 10 0 |
| Ferro-chrome— | |
| Max. 2% car. | £30 2 6 |
| Max. 1% car. | £33 17 6 |
| Max. 0·70% car. | £36 0 0 |
| 70% carbon-free | 10d. lb. |
| Nickel—99% | £170 0 0 to £175 0 0 |
| Ferro-cobalt | 9/- lb. |
| Aluminium 98/99% | £85 0 0 |
| Metallic chromium— | |
| 96/98% | 2/7 lb. |
| Ferro-manganese (net)— | |
| 76/80% loose | £11 0 0 |
| 76/80% packed | £12 0 0 |
| 76/80% export | £ 9 0 0 |
| Metallic manganese— | |
| 94/96% carbonless | 1/3 lb. |

Per ton unless otherwise stated.

## HIGH-SPEED TOOL STEEL.

| | |
|---|---|
| Finished bars, 14% tungsten | £0 2 0 |
| Finished bars, 18% tungsten | £0 2 9 |

Per lb. net, d/d buyers' works.

Extras—

| | |
|---|---|
| Rounds and squares, 3 in. and over | 4d. lb. |
| Rounds and squares, under ½ in. to ¼ in. | 3d. lb. |
| Do., under ¼ in. to 7/32 in. | 1/- lb. |
| Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in. | 3d. lb. |
| Do., under ½ in. × ¼ in. | 1/- lb. |
| Bevels of approved sizes and sections | 6d. lb. |

Bars cut to length, 10% extra.

## SCRAP.

| | £ s. d. | £ s. d. |
|---|---|---|
| South Wales | | |
| Heavy steel | 2 6 6 to | 2 7 6 |
| Bundled steel and shrngs. | 1 17 6 to | 2 3 6 |
| Mixed iron and steel | 1 17 6 to | 2 0 0 |
| Heavy cast iron | 2 7 0 to | 2 8 6 |
| Good machinery for foundries | | 2 12 6 |
| Cleveland— | | |
| Heavy steel | | 2 2 6 |
| Steel turnings | | 1 10 0 |
| Cast-iron borings | | 1 5 0 |
| Heavy forge | | 2 15 0 |
| W.I. piling scrap | | 2 11 6 |
| Cast-iron scrap | 2 7 6 to | 2 9 0 |
| Midlands— | | |
| Light cast-iron scrap | | 1 17 6 |
| Heavy wrought | | 3 0 0 |
| Steel turnings | | — |
| Scotland— | | |
| Heavy steel | | 2 5 0 |
| Ordinary cast iron | | 2 7 6 |
| Engineers' turnings | | 1 12 6 |
| Cast-iron borings | | 1 13 0 |
| Wrought-iron piling | | 2 12 6 |
| Heavy machinery | | 2 11 0 |

London—Merchants' buying prices delivered yard.

| | |
|---|---|
| Copper (clean) | 36 0 0 |
| Brass | 25 0 0 |
| Lead (less usual draft) | 10 0 0 |
| Tea lead | 7 0 0 |
| Zinc | 6 0 0 |
| New aluminium cuttings | 50 0 0 |
| Braziery copper | 32 0 0 |
| Gunmetal | 33 0 0 |
| Hollow pewter | 76 0 0 |
| Shaped black pewter | 56 0 0 |

## PIG-IRON.

*(f.o.t. unless otherwise stated.)*

| | |
|---|---|
| N.E. Coast— | |
| Foundry No. 1 | 61/- |
| Foundry No. 3 | 58/6 |
| Foundry No. 4 | 57/6 |
| Forge No. 4 | 57/- |
| Hematite No. 1 | 67/- |
| Hematite M/Nos. | 66/6 |
| N.W. Coast— | |
| Hem. M/Nos. d/d Glas. | 74/- |
| ,, d/d Birm. | 86/6 |
| Malleable iron d/d Birm. | 117/6 |
| Midlands— | |
| Staffs common* | — |
| ,, No. 4 forge* | 66/- |
| ,, No. 3 fdry.* | 71/- |
| Shrops basic | — |
| ,, Cold blast, ord. | — |
| ,, ,, roll iron | — |
| Northants forge* | 62/6 |
| ,, fdry. No. 3* | 67/6 |
| ,, fdry. No. 1* | 70/6 |
| Derbyshire forge* | 66/- |
| ,, fdry. No. 3* | 71/- |
| ,, fdry. No. 1* | 74/- |
| ,, basic* | — |

*d/d Black Country dist.

| | |
|---|---|
| Scotland— | |
| Foundry No. 1 | 76/- |
| ,, No. 3 | 73/6 |
| Hem. M/Nos. d/d | 72/- |
| Sheffield (d/d district)— | |
| Derby forge | 61/- |
| ,, fdry. No. 3 | 66/- |
| Lincs forge | — |
| ,, fdry. No. 3 | 66/- |
| E.C. hematite | 81/6 |
| W.C. hematite | 84/6 |
| Lancashire (d/d eq. Man.)— | |
| Derby forge | 64/6 |
| ,, fdry. No. 3 | 69/6 |
| Staffs fdry. No. 3 | 69/6 |
| Northants fdry. No. 3 | 68/- |
| Cleveland fdry. No. 3 | 69/6 |
| Dalzell, No. 3 (special) | 105/- to 107/6 |
| Summerlee, No. 3 | 89/- to 90/- |
| Glengarnock, No. 3 | — |
| Eglinton, No. 3 | 89/- to 90/- |
| Gartsherrie, No. 3 | 89/- to 90/- |
| Monkland, No. 3 | 89/- to 90/- |
| Shotts, No. 3 | 89/- to 90/- |

## FINISHED IRON AND STEEL.

*Usual District deliveries for iron; delivered consumers' station for steel.*

| Iron— | £ s. d. | £ s. d. |
|---|---|---|
| Bars (cr.) | 10 0 0 to | 10 10 0 |
| Nut and bolt iron | 8 12 6 to | 8 15 0 |
| Hoops | 10 10 0 to | 12 10 0 |
| Marked bars (Staffs) f.o.t. | | 12 10 0 |
| Gas strip | 10 10 0 to | 12 0 0 |
| Bolts and nuts, ¾ in. × 4 in. | | 14 5 0 |
| Steel— | | |
| Plates, ship, etc. | 8 15 0 to | 8 17 6 |
| Boiler plts. | 9 0 0 to | 9 15 0 |
| Chequer plts. | | 10 7 6 |
| Angles | | 8 7 6 |
| Tees | | 9 7 6 |
| Joists | | 8 15 0 |
| Rounds and squares, 3 in. to 5½ in. | | 9 7 6 |
| Rounds under 3 in. to ⅜ in. (Untested) | 7 2 6 to | 7 15 0 |
| Flats—8 in. wide and over | | 8 12 6 |
| ,, under 8 in. and over 5 in. | | 8 17 6 |
| Rails, heavy | 8 5 0 to | 8 10 0 |
| Fishplates | | 12 0 0 |
| Hoops (Staffs) | 9 5 0 to | 9 10 0 |
| Black sheets, 24g. | 8 10 0 to | 9 10 0 |
| Galv. cor. shts. 24g. | | 11 0 0 |
| Galv. flat sheets | | 11 10 0 |
| Galv. fencing wire, 8g. plain | | 12 0 0 |
| Billets, soft | 5 5 0 to | 5 12 6 |
| Billets, hard | 7 2 6 & up. | |
| Sheet bars | 5 0 0 to | 5 7 6 |
| Tin bars | 5 0 0 to | 5 7 6 |

## PHOSPHOR BRONZE.

| | Per lb. basis. |
|---|---|
| Strip | 11½d. |
| Sheet to 10 w.g. | 1/- |
| Wire | 1/1 |
| Rods | 1/- |
| Tubes | 1/7 |
| Castings | 1/- |

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

## NICKEL SILVER, &c.

| | Per lb. |
|---|---|
| Ingots for raising | 7d. to 1/1 |
| Rolled— | |
| To 9 in. wide | 1/1 to 1/7 |
| To 12 in. wide | 1/1½ to 1/7¼ |
| To 15 in. wide | 1/1½ to 1/7½ |
| To 18 in. wide | 1/2 to 1/8 |
| To 21 in. wide | 1/2½ to 1/8½ |
| To 25 in. wide | 1/3 to 1/9 |
| Ingots for spoons and forks | 7d. to 1/3½ |
| Ingots rolled to spoon size | 10d. to 1/6½ |
| Wire round— | |
| 3/- to 10 g. | 1/4½ to 1/11½ |

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

## AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

| | Dols. |
|---|---|
| No. 2 foundry, Phila. | 17.76 |
| No. 2 foundry, Valley | 17.00 |
| No. 2 foundry, Birm. | 12.00 |
| Basic | 18.26 |
| Bessemer | 18.76 |
| Malleable | 18.76 |
| Grey forge | 17.76 |
| Ferro-mang. 80% | 80.00 |
| O.-h. rails, h'y, at mill | 43.00 |
| Billets | 30.00 |
| Sheet bars | 30.00 |
| Wire rods | 35.00 |
| | Cents. |
| Iron bars, Phila. | 2.09 |
| Steel bars | 1.65 |
| Tank plates | 1.65 |
| Beams, etc. | 1.65 |
| Skelp, grooved steel | 1.65 |
| Skelp, sheared steel | 1.65 |
| Steel hoops | 1.70 |
| Sheets, black, No. 24 | 2.35 |
| Sheets, galv., No. 24 | 2.85 |
| Sheets, blue an'l'd, No. 13 | 2.05 |
| Wire nails | 1.90 |
| Plain wire | 2.20 |
| Barbed wire, galv. | 2.55 |
| Tinplates, 100-lb. box | $5.00 |

## COKE (at ovens).

| | |
|---|---|
| Welsh foundry | 22/- to 25/- |
| ,, furnace | 15/- to 17/- |
| Durham and Northumberland— | |
| ,, foundry | 13/6 to 14/- |
| ,, furnace | 13/6 |
| Midlands, foundry | — |
| ,, furnace | — |

## TINPLATES.

f.o.b. Bristol Channel ports.

| | |
|---|---|
| I.C. cokes | 20×14 box 15/- to 15/3 |
| ,, | 28×20 ,, 30/- to 30/6 |
| ,, | 20×10 ,, 21/10½ |
| ,, | 18¾×14 ,, 15/10½ |
| C.W. | 20×14 ,, 14/3 |
| ,, | 28×20 ,, 28/3 to 28/6 |
| ,, | 20×10 ,, 21/- |
| ,, | 18¾×14 ,, 14/9 to 15/- |
| Terneplates | 28×20 31/- per box basis f.o.b. |

## SWEDISH CHARCOAL IRON & STEEL.

| | |
|---|---|
| Pig-iron | £6 0 0 to £7 10 0 |
| Bars, hammered, basis | £17 10 0 to £18 10 0 |
| Bars and nail-rods, rolled, basis | £15 17 6 to £16 15 0 |
| Blooms | £10 0 0 to £12 0 0 |
| Keg steel | £32 0 0 to £33 0 0 |
| Faggot steel | £20 0 0 to £24 0 0 |
| Bars and rods dead soft, st'l | £11 0 0 to £14 0 0 |

All per English ton, f.o.b. Gothenburg.

### TUBES AND FITTINGS.

Over ⅛ in. up to 6 in.

| | Tubes. | Fittings. |
|---|---|---|
| Gas .. .. | 62½% | 47½% |
| Water .. | 58½% | 42½% |
| Steam .. | 55% | 37½% |

W.I. 12½% extra.

### DAILY FLUCTUATIONS.

**Standard Copper** (cash).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| Apr. | 16 .. | 42 | 16 | 3 | dec. | 6/3 |
| ,, | 17 .. | 42 | 13 | 9 | ,, | 2/6 |
| ,, | 20 .. | 42 | 10 | 0 | ,, | 3/9 |
| ,, | 21 .. | 42 | 11 | 3 | inc. | 1/3 |
| ,, | 22 .. | 42 | 11 | 3 | No | change |

**Electrolytic Copper.**

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| Apr. | 16 .. | 45 | 15 | 0 | dec. | 5/- |
| ,, | 17 .. | 45 | 15 | 0 | No | change |
| ,, | 20 .. | 45 | 10 | 0 | dec. | 5/- |
| ,, | 21 .. | 46 | 0 | 0 | inc. | 10/- |
| ,, | 22 .. | 46 | 0 | 0 | No | change |

**Standard Tin** (cash).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| Apr. | 16 .. | 111 | 15 | 0 | dec. | 60/- |
| ,, | 17 .. | 111 | 17 | 6 | inc. | 2/6 |
| ,, | 20 .. | 112 | 2 | 6 | ,, | 5/- |
| ,, | 21 .. | 110 | 17 | 6 | dec. | 25/- |
| ,, | 22 .. | 111 | 0 | 0 | inc. | 2/6 |

**Tin** (English ingots).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| Apr. | 16 .. | 112 | 15 | 0 | dec. | 60/- |
| ,, | 17 .. | 113 | 0 | 0 | inc. | 5/- |
| ,, | 20 .. | 113 | 5 | 0 | ,, | 5/- |
| ,, | 21 .. | 112 | 0 | 0 | dec. | 25/- |
| ,, | 22 .. | 112 | 0 | 0 | No | change |

**Zinc Sheets** (English).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| Apr. | 16 .. | 21 | 0 | 0 | No | change |
| ,, | 17 .. | 21 | 0 | 0 | ,, | ,, |
| ,, | 20 .. | 20 | 0 | 0 | dec. | 20/- |
| ,, | 21 .. | 20 | 0 | 0 | No | change |
| ,, | 22 .. | 20 | 0 | 0 | ,, | ,, |

**Spelter** (ordinary).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| Apr. | 16 .. | 11 | 7 | 6 | dec. | 3/9 |
| ,, | 17 .. | 11 | 7 | 6 | No | change |
| ,, | 20 .. | 11 | 5 | 0 | dec. | 2/6 |
| ,, | 21 .. | 11 | 3 | 9 | ,, | 1/3 |
| ,, | 22 .. | 11 | 5 | 0 | inc. | 1/3 |

**Lead** (English).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| Apr. | 16 .. | 14 | 0 | 0 | dec. | 10/- |
| ,, | 17 .. | 14 | 0 | 0 | No | change |
| ,, | 20 .. | 14 | 0 | 0 | ,, | ,, |
| ,, | 21 .. | 14 | 0 | 0 | ,, | ,, |
| ,, | 22 .. | 13 | 15 | 0 | dec. | 5/- |

## AVERAGE MONTHLY PRICES OF WEST COAST HEMATITE MIXED NUMBERS DELIVERED SHEFFIELD.

| Year | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Yearly average. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. |
| 1888 .. .. | 44 4 | 42 3 | 42 1½ | 42 0 | 41 2½ | 42 1½ | 42 6½ | 44 0 | 45 8½ | 44 6 | 44 6 | 45 3½ | 43 4 |
| 1889 .. .. | 44 4 | 45 2 | 47 3½ | 48 9½ | 48 6½ | 48 7½ | 50 1½ | 53 11 | 55 3 | 63 6 | 73 10 | 73 2 | 54 4½ |
| 1890 .. .. | 76 1½ | 65 1 | 63 3 | 55 1 | 53 9½ | 50 11 | 52 3½ | 56 4 | 58 0 | 58 2 | 57 5 | 54 4½ | 58 5 |
| 1891 .. .. | 52 9 | 50 10 | 48 11 | 47 9½ | 51 5 | 50 6 | 50 10 | 48 4 | 50 1 | 49 1½ | 48 3½ | 47 8 | 49 8½ |
| 1892 .. .. | 47 4 | 45 6 | 46 4½ | 47 8 | 49 5 | 50 4½ | 49 7½ | 49 10½ | 49 10½ | 48 8½ | 46 10 | 46 1½ | 48 2½ |
| 1893 .. .. | 46 0½ | 45 8 | 45 11 | 45 7 | 44 11 | 44 9½ | 44 10 | 45 3 | 45 0 | 44 6 | 44 7 | 45 8 | 45 3 |
| 1894 .. .. | 45 3 | 45 3 | 45 1½ | 45 1 | 43 11 | 43 11 | 43 9½ | 44 2 | 44 7½ | 43 7 | 43 5 | 43 3 | 44 3½ |
| 1895 .. .. | 42 8 | 42 5½ | 42 6 | 42 10 | 43 10 | 43 7½ | 44 10 | 45 11 | 49 11 | 48 9 | 47 7½ | 47 7½ | 45 2½ |
| 1896 .. .. | 47 0 | 48 9 | 48 9 | 48 2½ | 47 3 | 47 3 | 46 10 | 46 10 | 47 2 | 48 5 | 50 7 | 50 6 | 48 1½ |
| 1897 .. .. | 51 2 | 49 10 | 48 5 | 47 4 | 47 9½ | 48 6 | 47 0 | 47 3 | 47 3 | 47 0 | 48 3½ | 47 11 | 48 2 |
| 1898 .. .. | 48 9 | 48 10 | 49 4 | 49 8½ | 50 10 | 50 3½ | 51 0 | 52 5 | 53 11 | 55 8 | 57 3 | 56 10 | 52 1½ |
| 1899 .. .. | 59 1 | 59 9 | 57 7 | 59 6 | 64 7 | 70 10½ | 76 7½ | 72 2 | 74 3 | 75 0 | 78 1½ | 73 3 | 68 5 |
| 1900 .. .. | 75 3½ | 76 10 | 79 10 | 84 6 | 81 4 | 79 1½ | 83 4 | 81 5 | 79 11 | 76 10 | 77 8½ | 68 4 | 78 8 |
| 1901 .. .. | 60 2 | 59 0 | 57 9½ | 57 6½ | 57 8 | 57 4½ | 57 8 | 61 0 | 60 0½ | 59 9 | 58 7½ | 56 7 | 58 7½ |
| 1902 .. .. | 56 1 | 57 9½ | 59 3½ | 59 9 | 59 10½ | 60 0 | 60 0 | 60 8½ | 61 5 | 61 2 | 59 3 | 59 0 | 59 6 |
| 1903 .. .. | 58 5 | 58 8 | 61 1 | 59 5 | 57 10 | 57 3 | 56 7 | 56 3 | 55 9 | 54 8 | 52 4 | 52 4 | 56 8½ |
| 1904 .. .. | 52 8½ | 53 1 | 53 7 | 54 9 | 54 2 | 53 2½ | 52 9 | 52 5 | 52 2½ | 52 7 | 53 1 | 55 11½ | 53 5½ |
| 1905 .. .. | 57 9½ | 56 9 | 58 1 | 58 2 | 56 4 | 55 8 | 55 5½ | 56 7 | 61 0 | 68 9 | 69 9 | 70 11½ | 60 5½ |
| 1906 .. .. | 70 4½ | 65 2½ | 63 4½ | 63 9 | 64 5 | 64 6 | 64 1 | 66 2½ | 67 3 | 69 4½ | 72 4½ | 78 8½ | 67 5 |
| 1907 .. .. | 77 9 | 72 11 | 71 10 | 73 9 | 79 9½ | 76 9 | 77 9 | 78 4 | 75 11 | 72 9½ | 68 6 | 66 7 | 74 4 |
| 1908 .. .. | 62 7 | 59 1 | 61 6½ | 61 6½ | 61 4 | 59 1 | 57 9½ | 56 11 | 60 2 | 59 2 | 58 5½ | 57 7 | 59 7½ |
| 1909 .. .. | 51 4 | 56 5 | 55 3 | 56 1 | 56 4 | 57 0 | 56 8 | 58 0 | 61 0 | 61 1½ | 60 7½ | 61 4 | 58 1½ |
| 1910 .. .. | 64 0½ | 64 3½ | 66 10½ | 67 6½ | 66 2½ | 65 4 | 64 4½ | 65 6½ | 65 2 | 64 10½ | 64 6 | 65 6 | 65 4½ |
| 1911 .. .. | 66 9 | 66 1 | 64 10 | 63 1 | 62 1 | 62 0 | 61 2 | 62 2 | 62 1 | 61 1 | 61 10 | 64 0 | 63 1 |
| 1912 .. .. | 67 0 | 67 0 | 67 0 | 69 3 | 71 9½ | 72 11 | 75 9½ | 79 1½ | 82 2½ | 85 0 | 85 3½ | 86 6 | 75 9½ |
| 1913 .. .. | 86 6 | 86 6 | 86 3 | 85 0 | 83 6½ | 80 10½ | 78 1 | 76 10½ | 72 6 | 71 0 | 68 0 | 65 3 | 78 4½ |
| 1914 .. .. | 64 6 | 65 4½ | 65 6 | 64 11½ | 64 2½ | 64 0 | 64 0 | 68 11½ | 74 6½ | 71 0 | 65 4½ | 69 9½ | 66 10½ |
| 1915 .. .. | 78 9 | 100 6 | 103 1 | 113 6 | 111 9 | 114 0 | 116 3 | 115 2½ | 113 8½ | 121 1½ | 131 9½ | 139 6½ | 113 3 |
| 1916 .. .. | 135 0 | 135 0 | 133 4 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 129 2½ |
| 1917 .. .. | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 |
| 1918 .. .. | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 | 127 6 |
| 1919 .. .. | 127 6 | 127 6 | 127 6 | 127 6 | 180 6 | 184 3 | 195 4½ | 204 6 | 204 6 | 204 6 | 204 6 | 204 6 | 174 7 |
| 1920 .. .. | 224 9 | 235 0 | 245 0 | 275 0 | 290 0 | 295 0 | 295 0 | 295 0 | 295 0 | 295 0 | 295 0 | 280 0 | 284 11½ |
| 1921 .. .. | 263 4 | 228 4 | 180 0 | 180 0 | 180 0 | 160 0 | 160 0 | 157 6 | 142 0 | 128 6 | 121 0 | 115 6 | 167 9½ |
| 1922 .. .. | 125 0 | 117 6 | 115 0 | 115 0 | 115 0 | 115 0 | 113 1½ | 104 0 | 105 0 | 105 0 | 106 3 | 110 0 | 112 1 |
| 1923 .. .. | 109 0½ | 116 5½ | 133 11½ | 138 3½ | 134 2 | 125 0 | 115 7½ | 111 9 | 110 0 | 110 0 | 113 11 | 115 0 | 119 5½ |
| 1924 .. .. | 115 0 | 115 0 | 114 4½ | 112 6 | 112 6 | 112 6 | 111 0 | 110 0 | 110 0 | 105 4½ | 102 6 | 102 6 | 110 3½ |
| 1925 .. .. | 102 6 | 102 6 | 100 0 | 98 6 | 97 6 | 95 1½ | 92 6 | 90 6 | 88 3 | 87 0 | 88 1½ | 88 9½ | 94 3½ |
| 1926 .. .. | 90 1½ | 90 0 | 89 8½ | 89 0 | 89 0 | 89 0 | 90 2½ | 91 9 | 94 0 | 97 2½ | * | * | 91 0 |
| 1927 .. .. | 95 4½ | 95 6 | 96 6 | 95 6 | 95 3 | 94 0 | 92 10½ | 91 6 | 90 6 | 96 6 | 90 6 | 89 6 | 93 1½ |
| 1928 .. .. | 85 0 | 85 3 | 85 5 | 85 0 | 85 3 | 84 9 | 84 0 | 83 9 | 84 0 | 84 0 | 83 1 | 82 6 | 84 4 |
| 1929 .. .. | 82 10½ | 83 6 | 85 0 | 86 9 | 87 0 | 87 0 | 87 3 | 87 2½ | 87 6 | 89 6 | 89 6 | 89 10½ | 86 11 |
| 1930 .. .. | 91 6 | 91 6 | 91 6 | 90 0 | 89 7½ | 88 0 | 87 7½ | 86 6 | 86 6 | 86 6 | 86 6 | 86 6 | 88 6½ |
| 1931 .. .. | 86 6 | 84 6 | 84 6 | — | — | — | — | — | — | — | — | — | — |

* No prices available.


# WILLIAM JACKS & COMPANY,

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PIG-IRON.—Young Representative required for Midland district; must have had experience in sale of pig-iron and understand trade both in foundry and special irons.—Apply, with particulars and details of connection, Box 782, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

REPRESENTATIVE required by well-known foundry supply and equipment company for Lancashire, Cheshire, N.-W. Coast, etc.; must be well connected, practical demonstrator and good salesman.—Apply by letter, stating full particulars, experience, etc., to Box 780, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

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Any Member, Associate Member or Associate of the Institute of British Foundrymen who desires his qualifications to be inserted in the column must forward to the General Secretary of the Institute the following information:—(a) Name and address; (b) name of present employer (or last employer if unemployed); (c) brief particulars of qualifications, experience, and type of position required. The name will not be disclosed until the candidate is in communication with a prospective employer. Announcements will be inserted in two successive issues, unless announcers' requirements have been met with in the meantime.

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POSITION required as Foundry Foreman. Wide experience in iron and steel foundry practice, moulding machines and continuous casting, also sand and loam moulding up to 50 tons. Technically trained. (104)

## TENDER.

METROPOLITAN WATER BOARD.

TENDERS FOR THE SUPPLY OF STORES, ETC.

THE Metropolitan Water Board invite Tenders for the supply of the undermentioned Stores and Services, etc., for periods of 6 and 12 months, commencing June 1, 1931:—

Tender No.

1.—Bricks, firebricks, cement, etc.
8.—Iron and steel.
9.—Bolts and nuts, screws, files, shovels, steam tubes, etc.
12.—Fuel oil, oils (lubricating), kerosene, motor spirit, greases, tallow, etc.
19.—Iron, brass, gunmetal and other castings.
20.—G.M. stopcocks and ferrules, outlets and caps for fire hydrants.
22.—Timber.
23.—Maintenance of weighing machines.

Tenders must be submitted on the official forms, which may be obtained from the Chief Engineer by personal application at the offices of the Board (Room 155) or upon forwarding a stamped addressed sack envelope.

Applicants should refer to the number of the Tender for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board" and endorsed in the manner indicated in the Form of Tender, must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Monday, May 11, 1931.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery Avenue, E.C.1,
April 18, 1931.

## MACHINERY.

WANTED, Good Secondhand Hand Press Moulding Machine, suitable for Snap Flask work only, for boxes 12 in. x 12 in. x 4 in. deep.—Particulars, price, to Audley Engineering Company, Limited, Newport (Shropshire).

UNIVERSAL Mixers for Sand Colours, Chemicals, Blacklead, etc., different sizes. Also Super Abrasive Grinders and Steel Attrition Grinder and Dresser. Grind to any degree of fineness.—Booth & Son, Grinding, Crushing and Mixing Engineers, Congleton, Cheshire.


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1920 make, 4-wheel 14-in. x 22-in. LOCOMOTIVE (Barclay), copper firebox, steel tubes; 160 lbs. w.p.

1920 make, 4-wheel 14-in. x 20-in. LOCOMOTIVE (Hudswell Clarke), copper firebox; re-tubed 1930; 160 lbs. w.p.

New "POPULAR JUNIOR" BOILER, 5 ft. 6 in. high x 2 ft. 6 in. dia., 100 lbs. pressure.

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16,000 ft. of 1½-in. New Black Steel Screwed and Socketed PIPING in lengths of 18 ft. and upwards.

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FOUNDRY BLACKING AND COAL-DUST MANUFACTURING WORKS, Comprising Main Buildings, Sheds, Goods Entrance, etc. Adjoining railway siding; recently restored and in first-class condition.

Plant consists of new 60-h.p. Lancashire Dynamo Company's Electric Motor, ventilated, dust-proof type; one 30-h.p. Mavor Coulson Company's Electric Motor in excellent running order. Both these motors certified, tested and passed by National Boiler & General Insurance Company.

The Manufacturing Plant for both Foundry Blackings and Coal Dust are complete and in excellent working order. The grinding, mixing and screening machines recently thoroughly overhauled are largely automatic, very little labour being required.

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| 450 lb. "S" type cokefired .. .. | £80 |
| 450 lb. "A" type cokefired .. .. | £80 |
| 250 lb. "SA" type oilfired .. .. | £55 |
| 450 lb. "SA" type oilfired .. .. | £85 |
| 1,000 lb. "SA" type oilfired .. .. | £110 |

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